



IMPERIAL BUREAU OF PLANT GENETICS: HERBAGE PLANTS

BULLETIN No. 5.

RESEARCH IN PROGRESS ON HERBAGE PLANTS, FORAGE
CROPS AND GENERAL GRASSLAND PROBLEMS
IN THE BRITISH EMPIRE.

Price 2/6

AGRICULTURAL BUILDINGS,
ABERYSTWYTH,
WALES.

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IMPERIAL BUREAU OF PLANT GENETICS: HERBAGE PLANTS.

<i>Director</i>	..	..	..	..	..	Prof. R. G. STAPLEDON, M.B.E., M.A.
<i>Chief Officer</i>	..	..	..	..	..	Dr. R. O. WHYTE.
<i>Librarian</i>	..	..	..	..	..	Miss G. M. ROSEVEARE.

BULLETIN SERIES (Irregular).

- Bull. No. 1. Miscellaneous Information relating to Breeding of Herbage Plants. March 1930. (1s. 6d.)
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- Bull. No. 3. The Breeding of Herbage Plants; Technique adopted at the Welsh Plant Breeding Station. June 1931. (3s).
- Bull. No. 4. Abstract-Review of Lucerne Literature during the Period 1925-30. September 1931 (2s. 6d.)
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A. Introductory Note.

The information contained in this Bulletin is drawn largely from replies to various questionnaires which have been circulated from time to time from this Bureau. In certain cases when such information was not forthcoming, extracts were made from official reports. To the many correspondents who have supplied information as to work in progress, the Bureau tenders its sincerest thanks.

Certain obvious defects in the preparation of such a report will be apparent to the reader. For example, the length of each section is not always proportional to the amount or the value of the work in progress. Possibly other less obvious defects may have crept in during the recasting of the various replies received in the attempt to achieve some kind of uniformity, or for reasons associated with the lack of personal knowledge of the actual problems or plant material involved. Apart from this, however, it is thought that the information supplied is reasonably accurate and it is hoped that this report will be of some value to a large number of workers in the great variety of subjects and conditions in which their interests lie.

It has not been thought advisable to include a detailed report on the working of the Imperial Bureau for Herbage Plants, which has been organized as a centre for the collection and distribution of such information as comes within its terms of reference. The combined library of the Welsh Plant Breeding Station and the Imperial Bureau now receives or has access to most of the Journals in which papers of interest to herbage workers are published. A large number of additions have been made to the list published as a Supplement to Bulletin No. 1. Periodical visits are also paid to certain of the more important libraries in London and elsewhere in order to obtain perusal of some more unusual Journals.

After a preliminary experimental period during which Herbage Research Circulars and Current Literature Lists were prepared, the distribution side of our activities has been centred on a quarterly issue, Herbage Abstracts, intended to be a review of all current papers on herbage plant, forage crop and general grassland matters, and a Bulletin series, the numbers of which are issued irregularly as material and opportunity offers.

The Bureau is also prepared as far as its various duties permit to supply on special request more complete translations of foreign papers which are abstracted briefly in any of its publications. Other assistance such as supplying bibliographies on some special subject, procuring strains of herbage plants from foreign workers and placing research workers on similar problems in touch with each other has been given from time to time.

It must again be emphasised that the Bureau expects overseas workers to keep it supplied with information regarding results obtained by forwarding papers and reports, in order that they may be duly referred to in Herbage Abstracts. The Library is accumulating a collection of reprints of English and foreign articles, which may be lent to correspondents for short periods. Receipt of author's reprints, even if the journal has already been received, will always be cordially welcomed.

B. Great Britain and Northern Ireland.

I. GREAT BRITAIN (RESEARCH, ADVISORY AND OTHER CENTRES).

ABERDEEN. ROWETT RESEARCH INSTITUTE.

(a) Chemical analyses of pasture, natural and cultivated, from different areas in Great Britain, including samples from manurial trials under the scheme of the Pasture Sub-Committee.

(b) Chemical composition of the herbage from a poor hill pasture, throughout the complete cycle of twelve months.

(c) Grazing experiments to determine the effect of rotational grazing and frequent top-dressing with artificial fertilisers on the stock-carrying capacity of the pasture.

ABERYSTWYTH. WELSH PLANT BREEDING STATION.

The work on herbage plants at this Institution falls into two main groups (1) research relative to the breeding of herbage plants, and (2) investigations relative to the improvement and management of grassland.

The Breeding of Herbage Plants.

The species under more detailed study at present are (a) grasses—perennial and Italian ryegrass, cocksfoot, timothy, the fescues, meadow foxtail, Yorkshire fog, the meadow grasses and *Phalaris*; (b) legumes—red and white clovers, lucerne, birdsfoot trefoil and a number of annual legumes.

In connection with this work a large number of genetical problems are under review—such as the inheritance of lethal characters in seedlings; the inheritance of a great number of characters such as colour and hairiness in different parts of the plants; the effects of “in” and “out” breeding on fertility and vigour; the relation of time of flowering to open cross fertilisation; the ecotypical relationships of cocksfoot and some other species.

The actual breeding work is also supported by a large series of investigations designed to throw light on the question of what characteristics in particular are desirable in an ideal hay plant and an ideal pasture plant. In this connection and relative to the actual breeding work a great deal of research has been and still is devoted to the matter of technique.

The Improvement and Management of Grassland.

This work falls under five main headings (1) seeds mixtures, (2) manuring, (3) methods of grazing, (4) mechanical treatments, (5) a study of the factors influencing the productivity and economic value of pastures of different types. The work is being conducted both on enclosed farm lands and on open sheep walks.

(1) *Seeds Mixtures.*

A great deal of attention has been given to such matters as seedling establishment and competition and to a comparison of simple against complicated seeds mixtures, while more recently detailed comparisons are being made between the behaviour of the Station pedigree strains and strains from ordinary seed of commerce.

(2) *Manuring.*

Comparisons are made of the influence of manures on different strains—in relation to persistency, ratio of stem to leaf and other definite characteristics.

(3) *Methods of Grazing.*

Much work has been done relative to technique, and a technique is now being elaborated based on the use of tethered sheep—attention is devoted rather to the influence of different methods of grazing on the sward than on the grazing animal.

(4) *Mechanical Treatments.*

These methods are being tested for the most part on the poorest types of permanent grass and on open hill grazings in conjunction with manuring and seeding. These investigations are being supported by critical physiological research.

(5) *The factors influencing the Productivity and Economic Value of Pastures.*

Various methods are being elaborated with a view to the conduct of work. Standard ecological methods are being employed in conjunction with the use of tethered sheep, and a variety of methods of artificial defoliation. In this connection a great deal of research has been conducted since the foundation of the Station on so vexed a question as the conduct of botanical analyses of grassland.

ABERYSTWYTH. UNIVERSITY COLLEGE OF WALES.

(a) The effect of manures on the mineral content of the herbage of pastures cut at monthly intervals.

(b) Influence of maturity on the chemical composition of eleven species and strains of grasses.

(c) Experiments on the intensive manuring and management of pastures.

ABERYSTWYTH. DEPARTMENT OF AGRICULTURAL ECONOMICS.

General questions relating to the economic aspect of the question in Wales and elsewhere.

BANGOR. UNIVERSITY COLLEGE OF NORTH WALES, DEPARTMENT OF AGRICULTURE.

(a) Influence of strain and origin upon the persistency and yield of pasture species (scheme extensive and annually extended since 1924).

(b) Effect of inclusion of wild white clover in seeds mixtures upon live-weight increase in sheep and cattle.

(c) Effect of various initial seedings and of various schemes of manuring upon the establishment and maintenance of permanent meadow land.

(d) Effect of different manures and ground limestone upon lowland and upland pastures (tests not critical).

BRISTOL UNIVERSITY.

(a) Nutritive value of pasture grass under various systems of management and manurial treatment.

(b) Eradication of black-grass (*Alopecurus agrostis*). [Completed.]

(c) Variety trials of ryegrass and cocksfoot under intensive grazing.

(d) Pasture Research Committee's Experiments (two centres in Bristol Province).

(e) Effects of certain phosphatic and potassic fertilisers on grassland.

(f) Persistency of red clover strains.

CAMBRIDGE. ANIMAL NUTRITION INSTITUTE, SCHOOL OF AGRICULTURE.

(a) Investigations on the chemical changes occurring in certain species of grasses and clovers, keeping under review throughout the course of growth the relation between changes occurring under different environmental conditions and the nutritive value of the produce.

(b) Influence of intensity of grazing on the yield, composition and nutritive value of pasture herbage.

(c) Influence of intensive fertilising on the composition (chemical and botanical) and yield of cultivated pasture.

(d) Effect on digestibility and nutritive value of conserving young pasture grass by the method of artificial drying, at 100 degrees C. by means of steam, or by direct heat in a kiln.

CAMBRIDGE. UNIVERSITY FARM, SCHOOL OF AGRICULTURE.

The Eastern Counties of England are in general unfavourable to permanent grass mainly because of a low rainfall (about 21 inches). In these counties, moreover, there are about half-a-million acres of heavy clay (Gault, Boulder, and Oxford). On such soils arable farming is difficult and restricted. Both winter and summer cultivations are impeded by the nature of the soil and the cropping is limited. Thus, for example, it is not practicable in most cases to grow roots. In consequence of these facts there has been an inclination to put land down to permanent grass. The difficulties, however, have been many: both the establishment and the maintenance of grass is difficult where the average rainfall is 21 inches, fairly severe spring droughts are characteristic, and in winter water-logging frequently endures for some months.

During the past six years tentative grass experiments have been made on a number of farms in the Eastern Counties. These have shown that by suitable methods a pasture can be established and with appropriate management maintained in good condition for some five or six years. After that time deterioration often sets in rapidly. This takes the form of an invasion by what is known locally as water grass (*Agrostis* sp.). Probably the treading of stock on heavy clay land assists in this process by compacting the top soil and so upsetting aeration and drainage of the surface layer.

This situation suggests the desirability of a system of alternate husbandry, grass and arable crops alternating for five-year periods. Such a system is now being investigated on a large scale on the University Farm at Cambridge. The work is two-fold, consisting on the one hand of large scale trials and demonstrations, on the other of specific experiments. The main problems appear to be:

- (1) How best to sow the land down, e.g. after fallow, under corn, under mustard, in spring, in late summer, etc.
- (2) Early management; sheep *versus* haying in the first year.
- (3) Winter keep for stock.
- (4) The type of stocking.
- (5) The species of grasses and clovers best suited to the purpose, e.g. the value of red clover, of cocksfoot, of fine-leaved fescues, etc.
- (6) The use of special strains of herbage plants.

Drainage is of great importance and is a separate branch of experimentation. The specific experiments are laid out in the form of randomised blocks, grazing *versus* haying and other treatments being incorporated in the lay-out, and developmental studies all through crop life are also being made.

As an alternative to this treatment, the renovation of existing old heavy-land pasture is being tried by mechanical and chemical means.

CAMBRIDGE. NATIONAL INSTITUTE OF AGRICULTURAL BOTANY.

- (a) Testing and certification of wild white clover seed, sown in observation plots.
- (b) Growing on of samples described commercially as late-flowering red clover to study genuineness and nationality of those lots described as English.
- (c) Owing to their importance for golf courses, the two genera *Agrostis* and *Festuca* are under observation in laboratory and in the field.
- (d) Strain trials of lucerne—Provence (control), English, Grimm, Kansas, Hungarian, South African, Hunter River and Marlborough.
- (e) Strain trials of red clover—Fordham's broad red, English broad red, Dorset marlgrass, Suffolk late flowering red and Vale of Clwyd.
- (f) Strain trials of cocksfoot—Danish, New Zealand Akaroa, Svalöf Scandia, and a grazing strain.
- (g) A preliminary survey by means of observation plots of different strains of sainfoin including French Giant, Cotswold, Hampshire, Suffolk and other local English strains of common sainfoin.

CARDIFF. UNIVERSITY COLLEGE OF SOUTH WALES AND MONMOUTH.

- (a) Studies of various strains of giant and common sainfoin, as regards difference in persistence, at the College experimental ground, and in plots laid out in different types of soil.
- (b) Population study of different strains, following up habits, flowering and persistency. Depth and date of sowing of sainfoin.
- (c) Effect of cutting for hay at different stages with reference to yield and composition (in collaboration with the Agricultural Chemistry Department at Aberystwyth). [Completed].
- (d) Hardiness and persistence of certain strains of lucerne.
- (e) Seed mixtures for hay. [Being completed].

CORSTORPHINE. EDINBURGH. SCOTTISH SOCIETY FOR RESEARCH IN PLANT BREEDING.

- (a) Collection and comparison of strains of perennial ryegrass, cocksfoot and timothy and their progenies in plot culture. Crossings made each year under controlled conditions. Studies in genetics, ecology and self-sterility; also on the morphology of different forms or strains within each of the above species. Examination of parts of species populations (habitat types) to determine the status of the smaller taxonomic units occurring in the wild.
- (b) Work on timothy is concerned with *Phleum pratense* and *Phleum alpinum* and their hybrids, a member of the staff of the John Innes Horticultural Institution collaborating with the cytology. Crossings of two apparently inter-sterile groups (diploid and hexaploid) within the Linnaean species *Phleum pratense* with a tetraploid form of *Phleum alpinum*. Crossing of the artificial hexaploid obtained from the cross *Phleum pratense* (2n) $\times$ *Phleum alpinum* (4n) with a natural *Phleum pratense* (hexaploid).
- (c) An attempt to overcome the high degree of self-sterility in perennial ryegrass, cocksfoot and timothy by interplanting in one plot the clones of two cross-fertile plants which are similar in type.

(d) Comparisons of plants of different species and strains of grasses collected from exposed and contrasting situations for relative hardiness.

(e) Study of *Plantago maritima* as a pasture component. Efforts are being made to discover if this species possesses the astringent properties generally ascribed to *P. lanceolata*, as *P. maritima* appears to be better adapted for grazing.

(f) Three strains of pasture grasses, now in their second year of vegetative multiplication are being studied to devise suitable methods for multiplication and comparison of these grasses under field conditions.

The Society's staff is also interested in the following questions :—

(g) Chemical analysis of pasture, natural and cultivated.

(h) The effect on yield and chemical composition of pasture of frequent cutting as compared with cutting for hay.

(i) The effect of rotational grazing and frequent top-dressing with artificial fertilisers on the yield, chemical and botanical composition of pasture.

CRAIBSTONE, ABERDEEN. NORTH OF SCOTLAND COLLEGE OF AGRICULTURE.

(a) Production and study in field trials of "Craibstone" strains of cocksfoot, timothy and perennial ryegrass.

(b) Experiments concerned with the formation of temporary pastures—mixtures and treatment.

(c) Numerous pasture and hay experiments consist mainly of comparison of nationalities and strains of red clover, white clover, perennial ryegrass, cocksfoot and timothy.

(d) Studies on the effect of combination of stemmy and leafy types, stemmy types forming one mixture, leafy types of the same species forming another, while the two types are combined in a third seeds mixture.

EDINBURGH. EDINBURGH AND EAST OF SCOTLAND COLLEGE OF AGRICULTURE.

Certain members of the staff are concerned with studies on the grasslands of that part of Scotland, the Southern and Eastern districts, served by the College. The area is chiefly sheep farming, much of the grazing being permanent pasture, a considerable area semi-natural. Soil conditions, economic conditions and the drier climate of the East coast are adverse factors in any improvement schemes. Past records indicate that the higher grasslands (semi-natural) are inferior since sheep replaced cattle about 100 years ago. Studies on the ecology of grasslands and the effect of manures, renovation mixtures, ploughing up and reseedling of old grassland after a rotation are in progress. By a grassland survey on the grid method, it is hoped that data obtained from the flora and the conditions will indicate the lines along which improvement should proceed.

EDINBURGH. UNIVERSITY. DEPARTMENT OF BOTANY (PLANT PHYSIOLOGY AND AGRICULTURAL BOTANY.)

(a) Investigations into the classification and ready recognition of various species of the genus *Trifolium*. Study of their life histories from seed to fruiting plants.

(b) Study of plants suited to pasture production under conditions approximating to a Mediterranean climate.

(c) Studies on dormancy in the seed of species important in agriculture (grasses and clovers). The "hard" seed of the *Leguminosae* are being investigated as to cause, cure, and incidence.

EDINBURGH. THE HERBARIUM, ROYAL BOTANIC GARDEN.

Questions regarding the systematic position of forage and other plants are dealt with.

GLASGOW. WEST OF SCOTLAND AGRICULTURAL COLLEGE.

General questions connected with the grasslands of the area. (For certain detailed work, see under Section III. Scotland—Shire Experiments.)

HARPENDEN, HERTS. ROTHAMSTED EXPERIMENTAL STATION.

(a) The Classical Experiments. Studies are still in progress on the manuring of the Park Grass Plots; the examination of the effects of various combinations of fertilisers, with and without the application of lime, upon the yield of hay per acre and of dry matter per acre, and on the botanical composition of the herbage over a large number of years.

(b) Laying down Land to Grass. Several seeds mixtures are used, including perennial and Italian ryegrasses, cocksfoot, timothy, rough-stalked meadow grass and the clovers. Botanical surveys are made to study the success of establishment of the different types.

(c) Manuring of grassland. The effect of phosphatic and nitrogenous manure is studied by mowing the grass repeatedly during the season and finding the weight and composition of the cuttings.

(d) Gall midges whose larvae prevent seed formation in grasses are being studied. Those attacking meadow foxtail, timothy, *Festuca*, etc. are receiving attention. The method of control now being tested is to alter the cultivation of the crop, delaying the flowering of the grass until after the main flight is over, to the disadvantage of the insect. Trials are also in process to find out whether such grasses as timothy, ryegrasses, couch grass, etc. are host plants of the wheat midges.

(e) A study of the inoculation process in lucerne; the relation of the nodule organism to the host plant, and a study of the viability of the organism during transport in culture over long distances.

(f) Manuring trials. Effect of nitrogen phosphates and potash on growth and seed production of Italian ryegrass, cocksfoot and rough-stalked meadow grass.

(g) Competition between grasses and the effect of manuring on competition. Competition between grasses sown in pairs together, and grasses and clover, and the effect of nitrogen, potash and phosphate deficiency on the competition, between perennial ryegrass, Italian ryegrass, cocksfoot, timothy and rough-stalked meadow grass.

(h) The clover plant and the nodule organism. Investigations to trace the relationships of the clover plant and the nodule organism with the view to more rapid establishment and more vigorous growth of clover in new grassland.

ISLAND OF LEWIS. MACAULAY INSTITUTE FOR SOIL RESEARCH.

The greater part of the Island of Lewis is covered with peat, which varies in thickness from a few inches to 30 feet or more. Most of the island has an altitude of less than 300 feet, but there are hilly areas in the south-east and the south-west. In the hilly portions the peat is usually thin or absent. There are also considerable areas, especially near the villages, from which the peat has been removed for fuel, exposing a poor stony boulder clay. Along the coast there are in places stretches of sand rich in shells. The climate is mild and humid, and the annual rainfall about 50 inches.

The peat in Lewis is very acid and wet, and extremely poor in plant food substances. The vegetation on the wet moorland consists chiefly of sedges, *Molinia caerulea*, *Eriophorum*, etc. Its grazing value is extremely low.

On the Macaulay Demonstration farm, which was commenced in 1929, on Arnish Moor near Stornoway, various experiments in pasture establishment are being carried out. On account of the very humid climate cereal production is difficult and improvements in Lewis agriculture will depend mainly on the production of more and better pasture.

Various grass seed mixtures which have been found suitable on the peat lands of the Continent are being tried, and experiments are being conducted with new mixtures. Good pasture has been obtained on a field of 8 acres. Strains of grasses from the Welsh Plant Breeding Station will be tested in 1931, and cheap mixtures intended for the improvement of the common grazing have been sown on part of the farm.

Experiments with different amounts of drainage, lime and fertilisers are being carried out on these pasture plots.

An attempt is also being made to improve the land near the villages from which most of the peat has been removed for fuel, i.e. "skinned land." An area has been enclosed, and some parts of this land have been deeply trenched, others lightly dug, others merely levelled and others untouched. Cross dressings of lime and various fertilisers have been applied over part of the area, and the whole sown with grass seed mixture. Marked improvements are already evident over most of the plot, and the work is being continued with a view to arriving at the cheapest method of improvement.

KEW. ROYAL BOTANIC GARDENS.

1. Taxonomy and nomenclature. All questions concerning the systematics and nomenclature of plants.

2. Research. Investigations on the biology and genetics of wild British plants are in progress at Kew and at the Potterne Research Station, Wilts, which is affiliated with Kew. *Anthyllis vulneraria* is the only herbage plant of positive economic value which is being experimentally studied, but other species commonly found in herbage in this country are also being dealt with (*Ranunculus* spp., *Silene vulgaris*, *Centaurea* spp., *Saxifraga granulata*, etc.). Extensive field studies are being correlated with the results of intensive cultural and breeding research.

3. Herbaria of research material. Biological and genetical herbaria have been established at Kew, primarily for the reception of material recording research carried out at Potterne and Kew. While, however, it is accepted that every large properly equipped Research Station where genetical and biological research is carried out will file complete sets of sample specimens of all material investigated by members of its staff, the Director of the Royal Botanic Gardens, Kew, will be prepared to file authenticated material of any biological or genetical research by individual workers or from institutions lacking facilities for keeping the collections, or for making them available for consultation. The great importance of permanent records is now widely recognised and has been stated in detail in the *Journal of Ecology* XVIII. 379. 1930.

LEEDS. DEPARTMENT OF AGRICULTURE, UNIVERSITY OF LEEDS.

Work on grassland and herbage plants in this area in the past has been confined to the improvement of poor pasture, and experiments with seeds mixtures. A number of county trials, many of which are still in progress, on manuring of grassland and seeds mixtures experiments have been carried out from time to time. The best combination of ryegrass and red clover for a one-year ley seeds mixture is being investigated.

An investigation of the effect of sour soils upon the root development of some crop plants has been undertaken ; this is now being extended to include some important herbage and weed plants.

LONDON. IMPERIAL INSTITUTE, SOUTH KENSINGTON.

Chemical investigations of foodstuffs and fodders from overseas countries of the Empire are carried out in the laboratories of the Institute. A considerable amount of analytical data has been accumulated and is available on request.

LONDON. JOHN INNES HORTICULTURAL INSTITUTION, MERTON.

The work of this Institution is mainly concerned with the genetics and cytology of plants without special reference to economic problems. Polyploidy in *Phleum* spp. is studied in relation to geographical distribution. Also interspecific hybrids in *Avena*, *Hordeum*, etc.

LOUGHBOROUGH. MIDLAND AGRICULTURAL COLLEGE, SUTTON BONINGTON.

Trials of four varieties of hardy soya bean grown for seed. Lime and phosphatic manuring on pastures. Seeds mixtures, one-year, permanent or renovating, including wild white clover.

MANCHESTER. UNIVERSITY. ECONOMIC BRANCH OF ADVISORY DEPARTMENT.

A great deal of time has been devoted to research on the economic side of the management of pastures and meadows. The character of the established system has been carefully studied, and its merits tested by financial results. Financial motives have been presented to farmers for adopting experiments with an alternative system built up from achievements of recent research on the chemical, botanical and economic sides of the subject. A large number of experiments directly controlled by the farmers are under close observation and are giving results which support and complement those of research work done from other points of view.

NEWCASTLE-ON-TYNE. AGRICULTURAL DEPARTMENT OF ARMSTRONG COLLEGE.

Cockle Park. (County Agricultural Experiment Station).

(a) Manures for pasture in Tree Field, in relation to the live weight increase in sheep. Experiment carried on in four periods, the first for the nine years 1897-1905, the second for six years 1906-1911, the third for six years 1912-1917, and so on for every six years.

(b) Effects of manures and of cake feeding on Hanging Leaves pasture fields, also related to live weight increase of cattle and sheep.

(c) Intensive manuring and rotational grazing trial on Roundabouts pasture field.

(d) Drainage and manurial trials in North Field, Paradise.

(e) Manuring of pastures and for hay. Effect of manures on yield of hay from different seeds mixtures.

(f) Eradication of thistles. Use of basic slag and drainage ("slag-drainage") in controlling rushes in pastures.

(g) Variety trials and manuring of beans.

(h) Grass and clover seeds mixtures. Mixtures for one year or three or more years.

NEWPORT, SALOP. HARPER ADAMS AGRICULTURAL COLLEGE.

Demonstration plots in the Botanical Garden showing various types of gramineous, cruciferous

and leguminous plants of importance in agriculture. Plots sown of English and foreign red clovers, including a late-flowering type from Poland, and an improved variety of American sweet clover.

Seeds mixtures for one year's ley. Manuring of permanent pasture.

Treatment of permanent pasture under intensive grassland management with a dairy herd. Improvement by drainage and manuring of a wet, rush-infested tract of land.

NEWTON ABBOTT, DEVON. SEALE HAYNE AGRICULTURAL COLLEGE.

Study of the possibility of obtaining a stand of lucerne on the shale soils of Devon and Cornwall. Manurial trials to study the effect of potash.

Intensive grazing and manurial trials.

OXFORD. UNIVERSITY. AGRICULTURAL ECONOMICS RESEARCH INSTITUTE.

Various questions from the economic aspects, e.g. the cost per acre of grassland in various midland counties to the number of about twenty farms in all ; the length of the grazing season on each ; the amount of stock carried during the grazing season by each ; the cultivation and manurial treatment and the amount of hay produced from the portions mown.

READING. NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING.

An experiment on intensive manuring and stocking of pasture with dairy cows has been in progress for five years. Four paddocks of similar acreage and origin are used ; all receive the same basal dressings of lime, phosphates and potash, but two do not receive any nitrogenous manure, while the other two receive two to four applications of sulphate of ammonia (1 cwt. per acre at each application) annually. The results from each paddock are measured by the number of cow-grazing days and yield of milk produced. Chemical analysis of the soil and chemical and botanical analyses of the herbage are carried out periodically.

WYE. SOUTH EASTERN AGRICULTURAL COLLEGE, WYE, KENT.

(a) Seeds mixture trials for temporary leys.

(b) Permanent grass seed mixtures are sown down to study the following questions : (1) rate of seeding per acre, (2) growth of wild white clover, (3) growth of various strains of late-flowering red clovers, cocksfoot and perennial ryegrass. For permanent pasture manuring, slag is being compared with North African phosphate. Experiments on pasture manuring for early grass are arranged to test : (1) various nitrogenous manures, (2) slag against North African phosphate, (3) poultry against farmyard manure.

(c) The effect on the pasture, especially on the hay yield, of stocking with pigs.

II. ENGLAND—COUNTY ORGANISERS AND INSTITUTES.

BEDFORD.

Demonstration plots with different types of permanent seeds mixtures, and demonstrations of manuring of permanent grassland on old pastures and meadows are proposed.

BUCKS.

Seeds mixture demonstration, showing the value of improved mixtures containing wild white clover for laying down land to permanent pastures. Leafy strains of ryegrass, cocksfoot, etc., are being tested against commercial strains of the same grasses.

CAMBRIDGE.

Variety trials of red clover.
 Manuring of red clover and sainfoin.
 Inclusion of wild white clover in sainfoin.
 Seeds mixtures for one year's hay and for three or more year's ley.
 Demonstrations in laying down land to permanent pastures.
 Improvement of permanent pasture.
 Rotational manuring of meadow land.
 Intensive nitrogenous manuring of pasture.
 Times of applying manures.

CHESHIRE. Cheshire School of Agriculture, Reaseheath.

(a) Trials of seeds mixtures suitable for a smoky area where plants are liable to be coated with soot, and where the soil is normally very acid and wet. Plots laid down with single grasses or two grasses tend to show that indigenous perennial ryegrass, timothy, rough and smooth-stalked meadow grasses and certain strains of meadow foxtail are fairly reliable. Heavy doses of nitrogen have undoubtedly helped in the establishment of pastures in this area—small doses have been rather ineffective.

(b) Trials in slight variation of mixtures of the Cockle Park type. Substitution of indigenous perennial ryegrass and grazing strains of other grasses for commercial. Results suggest that up to the present the former are less palatable and lower in yield.

(c) Trials on the effect of management on grassland sown with various seeds mixtures.

- (i) Continuous mowing for hay. (ii) Alternate mowing and grazing.
 (iii) Judicious grazing for hay. (iv) Very hard grazing.

(d) Trials of cutting herbage when 3—4 ins. high to determine amount of grass produced in season.

(e) Trials of practical possibilities of intensive nitrogenous manuring and grazing with observations on effect on herbage.

CUMBERLAND (Farm School, Newton Rigg, Penrith).
and**WESTMORLAND** *Seed Mixtures.*

A. Experiments are in progress on modifications of the Cockle Park mixture to suit particular conditions.

1. To provide more winter green grass, e.g. rough-stalked meadow grass in place of cocksfoot.
2. To test more permanent forms of red clover likely to be suitable for mowing as second and third year seeds.

B. Trials of lucerne and timothy meadows for mowing permanently or over long periods.

C. Comparisons of indigenous grasses with commercial samples, again on the lines of the Cockle Park mixture.

Manures.

General improvement of poor pasture rather than intensive use of good pasture except in very highly rented areas. Experiments to find whether time of application of the longer lasting phosphates and lime vary much in their effects, according to place and time of application in the course of rotation.

General.

Temporary grassland competitions in the counties of Cumberland and Westmorland as a means of calling attention to grassland management.

DEVON.

During the past six years, extensive experiments have been carried out in Devon in connection with grass seeds mixtures, the Cockle Park mixture being taken as standard.

One year leys.

- (a) Standard mixture tried under various conditions.
- (b) Mixtures designed to give early keep and better aftermath without reducing hay crop.
- (c) Variations obtained by substituting Italian ryegrass for perennial ryegrass.
- (d) Comparisons of various strains of red clovers.

Three year leys.

- (a) Standard mixture tried under various conditions.
- (b) Broad red clover introduced, and late flowering red clover reduced.
- (c) Broad red clover introduced, late flowering red clover reduced, and Italian ryegrass included in place of part perennial ryegrass.
- (d) Complicated or unbalanced mixtures.
- (e) Mixture without wild white clover.
- (f) Dorset marl included in place of some or all late flowering red clover.
- (g) Cornish marl included in place of some or all late flowering red clover.
- (h) Broad red clover in place of late flowering red clover.
- (i) Revised standard mixture to give, in addition, early keep and aftermath.
- (j) Various strains and various quantities of cocksfoot and perennial ryegrass.
- (k) Various strains of wild white clover.
- (l) Various strains of late and early red clovers.
- (m) Various strains of late and early red clovers to test persistency.
- (n) Various types of grazing mixtures.

Grassland Improvement.

- (a) Values of various phosphatic dressings on different soils and under different conditions.
- (b) Economic values of various phosphatic dressings as indicated by improvement in relation to cost of dressings.
- (c) Effects of lime and/or potash under different circumstances when applied alone and in conjunction with various phosphatic manures.
- (d) Intensive nitrogenous manuring of pastures for grazing and early keep.
- (e) Mechanical improvement of old grass by surface cultivation.

DORSET

Observations on seeds mixtures with special reference to the advisability of including cocksfoot. Results suggest that this grass should be substituted by meadow fescue, rough-stalked meadow grass and crested dogstail.

*ESSEX.**Seeds Mixtures.*

A large number of observation plots have been laid down.

Manurial Trials on Grasses.

(1) Quantitative (for the Basic Slag Committee in collaboration with Rothamsted). Latin square arrangements of plots with five replications are being used to test the effect of different phosphate fertilisers on the yield of seed hay on the two principal types of soil in the county, viz. Boulder clay and London clay.

(2) Qualitative (for the Pasture Grass Sub-Committee of the Ministry of Agriculture). These trials consist of duplicate strips of grass measured off in a London clay meadow which has received

no treatment for many years. Two of the strips have had basal dressings of minerals (applied in 1929), two have had the same basal dressing, and in addition $\frac{1}{2}$ cwt. of sulphate of ammonia per acre every three weeks during the growing season. Two strips have received no treatment. All the plots are cut every three weeks during growth by means of a lawn mower, the yields are recorded and dry matter and nitrogen determined. The 1930 samples will be examined for mineral composition by the Rowett Institute.

Spartina Townsendii.

Work is in progress with this grass with the following objects :—

- (a) prevention of coast erosion.
- (b) seed production for overseas demand.
- (c) crop as emergency food for stock.
- (d) examining other economic possibilities of the plant.

HERTFORDSHIRE. Institute of Agriculture, Oaklands, St. Albans.

Experiments at the Institute.

The effect of nitrogenous manuring of grassland which had been divided into plots for rotational grazing (account published). The plots are now being used to study the effect of balanced manures *versus* nitrogen alone, the nitrogen being applied in the same quantity per plot, but at varying times throughout the season.

Seeds mixtures are being studied, with special regard to comparison of commercial and other strains of grasses and clovers. Lucerne has been incorporated in the mixtures in some plots. Certain strains of cocksfoot and timothy are sown for seed production.

Experiments in the County.

Seeds mixture trials, including in some cases cocksfoot, wild white clover and subterranean clover. Manurial trials with Latin square method, to test effect of phosphates and potash on grass, and to test nitrogen in its various forms for hay.

ISLE OF MAN.

An experimental field of twelve acres, with uniform soil conditions has been set aside for variety trials of grain, roots, grasses and clovers. The different varieties are replicated as often as possible, with a "check" plot of some standard variety between one variety and the next. The yield of each plot of the different varieties is expressed as a percentage of the average yield of the two adjacent check plots, while the yield of each variety is given as the average of the yields of all plots of that variety.

Seeds mixtures sown on plots $\frac{1}{12}$ acre each contained the following species in varying proportions : Italian ryegrass, perennial ryegrass, cocksfoot, timothy, English broad-leaved red clover and English late-flowering clover, alsike, New Zealand wild white and Kentish wild white clover.

Thirteen strips $47\frac{1}{2}$ yards long by 5 yards wide are sown each with a pure grass, and the following clovers are sown in strips 6 yards wide at right angles to the grasses : English broad-leaved red clover, English late-flowering red clover, Montgomery late-flowering, wild white and Kentish wild white.

A similar experiment is in progress with five different strains of cocksfoot sown across a simple seeds mixture.

Pure clover trial plots are also laid down, together with sainfoin and lucerne.

ISLE OF WIGHT.

Seeds mixture trials laid down in 1929. New trials will include Aberystwyth strains of red clover and grasses, while seed production of indigenous cocksfoot and timothy will be carried out.

LANCASHIRE.

Considerable work on manurial treatment of grassland ; the results indicate the necessity of applying lime to grassland in the industrial areas.

LEICESTERSHIRE.

Grassland improvement trials at Shoby.

Surface cultivation by chain harrowing, Parmiter harrows, disc harrows, the rejuvenator and drag harrows is studied.

The importance of density of stocking and adequate grazing.

Botanical analyses of herbage.

Effect of phosphatic fertilisers.

Comparison between basic slag and North African phosphate.

LINDSEY, LINGS.

Seed mixture experiments for one or more than one year leys.

Improvement of pastures by manuring and renovating mixtures.

Improvement of old matted pasture.

HOLLAND, LINGS.

A few demonstration plots of various clovers and ryegrasses for a one year's ley at the Institute Farm.

NORFOLK.

Trials with various grass and clover mixtures in the conversion of arable land to grass.

The use of various grasses in temporary mixtures for hay.

Improvement of permanent grassland by manuring.

NORTHAMPTON. County Farm Institute, Moulton.*Short term leys.*

Seeds mixtures trials, including rye grass (perennial and Italian), cocksfoot, red clover strains, alsike and Dutch white clover. The effect of nitrogenous top-dressing on yield and quality.

Influence on the yield of the succeeding cereal crop of wild white clover when included in a two-years' ley. Persistency and resistance to disease of different varieties of late-flowering red clover. Trials with indigenous strains of grasses and clovers, and their response to heavy manuring.

Permanent Grassland.

The various methods of grassland improvement are employed. Slag is beneficial, but there is a potash deficiency mainly on the "red land" derived from Northampton sandstone. In a few cases no results have been obtained until the land has received potash as well. Rock phosphates have been successful in some cases, but on the lighter land, good stocking and grazing are very important.

NOTTINGHAM.

Grassland manurial demonstrations. By a special arrangement of plots, basic slag and a mineral phosphate-superphosphate mixture are compared separately and in combination with muriate of potash and sulphate of ammonia.

*SOMERSET.**Grassland Manurial Trials.*

Series of plots to ascertain the effects of phosphatic manures with and without potash have been laid down from 1924 onwards. In most cases a plot receiving a dressing of lime was included in the series.

Seeds Mixtures.

Work has proceeded along two lines, namely mixtures for one year's ley or for three years' ley or permanent. A standard mixture is laid down at each centre and compared with another mixture or mixtures differing slightly in composition. The suitability of different strains of grasses and clovers for permanent pasture conditions.

Red clovers of different nationalities and strains are being studied as regards suitability for one year's ley.

STAFFORDSHIRE. Farm Institute, Penkridge.

Manurial trials for demonstration purposes. Trial of intensive manuring, down for four years. Carbonate of lime has given poor results on old sour turf and practically no results on peaty soil. Ground mineral phosphates have given better results without lime than with in several cases. Basic slag and potash salts are most satisfactory for peaty soils.

SUFFOLK EAST.

- (1) Manurial trials on grass at Saxmundham, in progress since 1901.
- (2) Seeds mixture trials commenced 1904, ploughed up 1929.
- (3) Seeds mixture trials in duplicate, started 1926.
- (4) Observational manurial trials at many centres, on grass.
- (5) Lucerne mixtures—effect of chalk and lime.
- (6) Lucerne—inoculation trials.
- (7) Intensive manuring of grass on small plots.
- (8) Nationality trials with late-flowering red clover.

SUFFOLK WEST.

No seed mixture or manurial trials yet in progress.

Nationality trials for strains of late-flowering red clover.

SURREY.

Trials with various seeds mixtures to ascertain the most suitable mixture for one year's ley and demonstration plots of longer leys.

Demonstration plots showing the most effective way of applying phosphates and potash, and latterly, the possibility of ensuring earlier grazing by the application of nitrogenous fertilisers.

SUSSEX EAST.

Little critical work. Manurial experiments using phosphates and potash as a means of renovating poor pasture, employing also wild white clover seeds.

SUSSEX WEST.

Trials of lucerne as a four years' ley in regular rotation.

WESTMORLAND. See Cumberland.

Edinburgh and East of Scotland College of Agriculture.

ANGUS.

This county is little concerned with permanent pastures, the principal aim being the provision of the best possible short term (one to three years) rotation grazing. The increase of cocksfoot in the seeds mixtures has been very marked in recent years but there is a tendency to omit bottom grasses. Rough stalked meadow grass is now being more freely used. Broad and late flowering red are the most popular clovers.

III. SCOTLAND—COLLEGES OF AGRICULTURE.

Edinburgh and East of Scotland College of Agriculture.

WEST LOTHIAN and PEEBLES.

Manurial trials, using different forms of phosphates with or without potash, on grassland. Rough harrowing and burning of old grass at high altitudes has given good results.

BERWICK, ROXBURGH and SELKIRK.

Manuring tests on pastures.

- (1) Comparison of different forms of phosphate on hill and permanent pastures.
- (2) Comparison of mineral phosphate and potassic mineral phosphates on hill, permanent and temporary pastures.
- (3) Comparison of basic slag and potassic basic slag on similar areas.
- (4) Complete manurial dressing.
- (5) Comparison of forms of potash.
- (6) Effect of lime.
- (7) Autumn *versus* spring manuring of "seeds."
- (8) Intensive system of grassland manuring and grazing.

Various trials with seeds mixtures, renovation mixtures and mechanical treatment of old pastures.

EAST PERTH, CLACKMANNAN and KINROSS.

Manurial trials largely for demonstration purposes, are in progress. The soils are frequently lime deficient. A liberal dressing of basic slag or mineral phosphates is necessary to effect an improvement in the land, especially where sheep breeding is being practised. Good pastures are easily made where cattle are fed. Seeds mixture trials are being commenced.

Cultural operations on old matted grassland, treating with heavy harrows.

Ploughing and reseedling without an intervening rotation.

Reclamation of mud flats on the Tay, using *Spartina Townsendii*.

West of Scotland Agricultural College.

DUMFRIES.

General work on the grasslands of the area.

KIRKCUDBRIGHT.

Grassland improvement by manuring ; (a) phosphates and potash on old grassland and rotation pasture ; (b) the effect of dressings of sulphate of ammonia, nitro-chalk and cyanamide top-dressings (alone and in complete mixtures) in the production of early grass ; (c) the effect of liming on laying down land to permanent pasture.

Seed mixtures using (a) commercial strains, (b) commercial and leafy strains, (c) mixtures entirely of leafy strains and (d) variation in clover inclusions.

The effect of Ransome's cultivator on old grass land with and without subsequent manuring, and the use of the pitch-pole harrow.

LANARK.

Extensive manurial and seeds mixtures trials, largely of a demonstrational nature.

STIRLING.

Intensive manurial trials using various phosphates and potash manures, with harrowing of the grassland.

WEST PERTH and DUMBARTON.

Improvement of poor old grassland by the application of phosphates with and without potash, and sometimes with dressings of nitrogen in the spring, experiments being arranged on a four plot scheme. Thorough harrowing and close grazing are employed where practicable before application of manures. Trials are carried out with various nitrogenous manures, in order to obtain an earlier spring bite.

Experiments demonstrating the benefits of liming and application of phosphates and potash prior to sowing out new grass swards.

Seeds mixture trials of Danish *versus* New Zealand cocksfoot and of New Zealand *versus* Kentish wild white clover. Trials with various pedigree seeds mixtures, compared with farmers' own mixture.

WIGTOWN.

General demonstrational and advisory work on questions relating to grassland management. There is little permanent pasture, the area being chiefly dairying.

AYR.

The effect of phosphate (as mineral phosphate or basic slag) and potash on grassland. Testing of nitrogenous manures with rotational grazing under varying conditions of soil and altitude. The breaking up, liming, manuring and reseeding of "run-out" hill and other permanent pastures. The use of potassic mineral phosphate in similar conditions. Seeds mixtures include smaller quantities of ryegrass. New Zealand wild white clover tested against English wild white, spreads much more slowly. Trials of indigenous *versus* commercial strains. Nationality trials of red clover. Application of lime when sowing out new swards. Application of potash at or soon after sowing of red clover.

North of Scotland College of Agriculture.

CAITHNESS.

Reclamation of rush-infested land : (1) drainage and manuring, (2) surface drains and manuring, (3) cutting at different times and manuring.

SUTHERLAND.

Experiment to demonstrate the effect of using a properly balanced grass and clover seeds mixture, and the use of Italian ryegrass to provide an extra bite of new grass for ewes and lambs.

A grass and clover seed mixture for hay and two or three years pasture mixture according to nature of soil, combined with a manurial trial of phosphates, potash and nitrogen.

ROSS AND CROMARTY.

Seeds mixtures for smallholdings. Comparison of wild white and late-flowering red clover. Demonstration of the effect of varying the amounts of ryegrass, timothy and cocksfoot in grass seed mixtures to provide an early bite, a crop of hay and three years' pasture.

MORAYSHIRE.

(1) To test the effect of reducing the amount of perennial ryegrass in a grass seed mixture and increasing natural grasses (cocksfoot and timothy) with regard to pasture establishment and the control of wild white clover in the third and fourth year.

(2) To test the effect of sowing the grass seed mixture at different depths, with particular reference to the development of red clover.

(3) To demonstrate the effect of insoluble phosphate and potash on the development of red clover in hay.

(4) To test the application of phosphate, potash and common salt as a method of improving old pasture.

INVERNESS.

To demonstrate a suitable mixture of grass and clover seeds to provide an early bite of young grass for ewes and lambs, also a good crop of hay, and for two or three years' pasture. Manuring of young grass.

BANFF.

(1) Seeds mixtures to test the effect of reducing the seeding of perennial ryegrass and increasing the seeding of natural grasses.

(2) Depths of seeding red clover seed.

(3) Manuring of grass, type of manure and time of application.

WEST ABERDEEN.

(1) Grass seed mixtures, demonstrating the value of mixtures suitable for light land.

(2) Permanent pasture. To acquire information on the laying down and renovation of permanent pasture by use of suitable grass seed mixtures, cultivation and manuring.

(3) Manuring, to ascertain the effect of dressing grass with slag and ground mineral phosphate.

EAST ABERDEEN.

Grass seeds mixtures and the manuring of permanent grass with basic slag and ground mineral phosphate.

KINCARDINE.

(1) Suitable grass mixture for hay and pasture on fairly heavy soil, including Italian ryegrass.

(2) Different quantities of ryegrass for hay and pasture mixtures.

(3) Inclusion of natural grasses in one-year hay mixture.

(4) Manuring of hay.

ORKNEY.

(1) Improvement of hay—variety trials with English and foreign red clover strains. Manuring of hay.

(2) Pastures—seed mixtures with varying quantities of cocksfoot, timothy and rough-stalked meadow grass, and with New Zealand and Kentish wild white clover. New Zealand wild white is very successful. Nitrogenous manuring of first year's grass for early grazing for sheep.

(3) Slag, mineral phosphates and potash on old pastures.

(4) Reclamation of hill land by surface cultivation, manuring and seeding *versus* manuring alone (slag and mineral phosphate) also heather burning, manuring and seeding.

(5) Application of shell-sand to sow out for grass.

SHETLAND.

(1) Rotation grass seed mixtures, (2) manuring of young grass for hay, (3) improvement of hill pasture by surface draining, seeding and application of basic slag or ground mineral phosphate.

IV. WALES—COUNTY EXPERIMENTS.

BRECON and RADNOR.

Seeds mixture trials in collaboration with the Welsh Plant Breeding Station, Aberystwyth.

DENBIGH. Llysfas Farm Institute, Ruthin.

The framing of suitable seeds mixtures and the testing of pedigree seed against commercial.

GLAMORGAN.

Seeds mixture trials.

MERIONETH.

Critical investigations on seeds mixtures.

- (1) Indigenous mixtures *versus* a commercial mixture on lowland centres.
- (2) Bottom grass—wild white clover mixture *versus* top-grass—wild white clover mixtures, including two of the latter type containing an excess of one indigenous top-grass, for the formation of a good sward on upland pastures.
- (3) Various simple mixtures for the seeding down of peat.

MONMOUTH.

Manurial experiments and demonstrations on grassland.

MONTGOMERY.

Manures for grassland and seed mixtures suitable for reseeded worn out pastures or improvement of upland grazings.

V. NORTHERN IRELAND.

BELFAST. QUEENS UNIVERSITY, DEPARTMENT OF AGRICULTURAL BOTANY.
HILLSBOROUGH, AGRICULTURAL RESEARCH STATION (MINISTRY
OF AGRICULTURE).

The Department has, at present, no land under its own control. Experimental work is conducted in the counties and at the Research Station. Seeds mixture experiments have been laid out in various districts; the herbage from the plots is subjected to botanical analyses. The primary object of these is to ascertain pasture values rather than hay values for the species. Plots to ascertain hay values for strains of red and wild white clovers, and hay and seed values of strains of ryegrasses have been down for several years.

At Hillsborough, crossed plots of grasses and clovers are laid down to ascertain competition values of species under local conditions. Pasture renovation mixtures are under trial, and analyses are made to observe effect of manuring on botanical constitution of the herbage.

BELFAST. SEED TESTING AND PLANT DISEASES DIVISION.
MINISTRY OF AGRICULTURE.

Seeds.

Tests in shipments to America—ryegrass—influence of temperature and moisture upon retention of powers of germination.

The value of the quartz lamp tests for distinguishing between perennial and Italian ryegrass in the absence of awns, and between strains of commercial "perennial" is under investigation, backed by genetical work on the inheritance of the fluorescence character.

Weeds.

Trials of sodium chlorate as weed killer for arable land, and as regards its influence in controlling rushes in pasture. Chlorate as a sprayed solution compared with dry broadcast.

Mixtures for Sports Grounds.

Various species of *Agrostis*, *Festuca* and *Poa* are under control.

C. Overseas Countries.

CANADA.

DIRECTOR, DOMINION EXPERIMENTAL FARMS, DEPARTMENT OF AGRICULTURE, OTTAWA.
DOMINION AGROSTOLOGIST, CENTRAL EXPERIMENTAL FARMS, OTTAWA.

The experimental projects in progress at these institutions are reproduced here in the tabulated form adopted in the official guide published by the Minister of Agriculture.

	Ottawa	Charlottetown	Kentville	Napan	Fredericton	Ste. Anne	Cap Rouge	Lennoxville	Farnham	La Ferme	Harrow	Kapuskasing	Morden	Brandon	Indian Head	Rosthern	Scott	Swift Current	Lethbridge	Lacombe	Invermere	Summerland	Agassiz	Sidney	Beaverlodge	Ft. Vermilion	Sub-Stations
<i>Alfalfa.</i>																											
Variety tests	*		*	*		*		*		*		*		*	*	*	*	*	*	*	*	*	*	*	*	*	
Inoculation					*																						
Liming																											
Broadcast vs. rows for hay ..				*								*															
Rates of seeding for hay. ..												*			*										*	*	
Rates of seeding for seed ..														*	*				*						*	*	
Advantages of a nurse crop ..				*								*						*		*					*	*	
Factors influencing seed-setting ..																			*	*					*	*	
<i>Alsike Clover</i>																											
Methods of seeding for seed production												*								*							
Variety tests																				*							
<i>Annual Hay Crops.</i>																											
Time of harvesting														*	*	*	*	*	*	*	*	*	*	*	*	*	
Trials of grain varieties	*					*				*		*		*	*	*	*	*	*	*	*	*	*	*	*	*	
" " legume	*							*				*		*	*	*	*	*	*	*	*	*	*	*	*	*	
" " other grasses				*		*		*						*	*	*	*	*	*	*	*	*	*	*	*	*	
" " mixtures	*					*				*				*	*	*	*	*	*	*	*	*	*	*	*	*	
<i>Seeding.</i>																											
Breeding of timothy.	*																										
" " orchard grass	*																										
" " western rye	*																										
" " brome grass	*			*		*								*	*	*	*	*	*	*	*	*	*	*	*	*	
" " Kentucky bluegrass ..	*					*								*	*	*	*	*	*	*	*	*	*	*	*	*	
" " red top	*					*								*	*	*	*	*	*	*	*	*	*	*	*	*	
" " meadow fescue	*			*		*								*	*	*	*	*	*	*	*	*	*	*	*	*	
" " alfalfa	*			*		*								*	*	*	*	*	*	*	*	*	*	*	*	*	
" " sweet clover (white blos.)														*	*	*	*	*	*	*	*	*	*	*	*	*	
" " sweet clover (yellow) ..														*	*	*	*	*	*	*	*	*	*	*	*	*	
" " red clover	*					*								*	*	*	*	*	*	*	*	*	*	*	*	*	
" " alsike clover	*					*								*	*	*	*	*	*	*	*	*	*	*	*	*	
" " soybeans	*					*				*				*	*	*	*	*	*	*	*	*	*	*	*	*	
<i>Brome Grass.</i>																											
Methods of seeding for hay ..																				*							
Rates of seeding for hay ..																		*									
<i>Room corn.</i>																											
Variety tests										*																	
<i>Hay and Pasture Mixtures.</i>																											
Seeding at different dates ..	*					*								*	*	*	*	*	*	*	*	*	*	*	*	*	
Alfalfa as a base	*													*	*	*	*	*	*	*	*	*	*	*	*	*	
Sweet clover as a base	*									*		*		*	*	*	*	*	*	*	*	*	*	*	*	*	
Red clover as a base	*				*	*				*		*		*	*	*	*	*	*	*	*	*	*	*	*	*	
Mixed clovers as a base	*				*	*				*		*		*	*	*	*	*	*	*	*	*	*	*	*	*	
Mixed grasses					*					*		*						*						*	*	*	
Grasses and clovers alone and in combination						*						*		*	*	*	*	*	*	*	*	*	*	*	*	*	

Continued Overleaf

	Ottawa	Charlottetown	Kentville	Nappan	Fredericton	Ste. Anne	Cap Rouge	Lennoxville	Farnham	La Ferme	Harrow	Kapuskasing	Morden	Brandon	Indian Head	Rosthern ¹	Scott	Swift Current	Lethbridge	Lacombe	Invermere	Summerland	Agassiz	Sidney	Beaverlodge	Ft. Vermilion	Sub-Stations
Alsike clovers as a base					*																					*	
Seeding hay mixtures with different nurse crops.					*																				*	*	
<i>Millets</i>																											
Variety tests	*			*		*				*				*				*			*					*	
<i>Orchard Grass</i>																											
Variety tests for yield and suitability																								*			
<i>Plant Introduction.</i>																											
Miscellaneous grasses	*					*				*		*		*	*			*	*	*	*						
Miscellaneous legumes	*									*								*	*	*	*						
Forage crops other than legumes and grasses	*				*													*	*	*	*						
<i>Red Clover</i>																											
Variety tests	*	*	*	*		*	*		*	*		*		*	*	*			*	*	*	*			*	*	
Inoculation												*															
Rows vs. broadcast seeding for seed production										*		*		*	*	*											
Cutting at different dates for hay ..		*										*							*	*	*	*					
Cutting at different dates for seed ..								*				*							*	*	*	*					
Seed growing vs. hay for profit ..					*																				*	*	
Seeding with vs. without a nurse crop																									*	*	
<i>Soy beans</i>												*							*								
Variety tests for forage			*		*						*								*								
<i>Sweet clover</i>																											
Variety tests	*	*	*	*				*		*		*		*	*	*	*	*	*	*	*	*			*	*	
Methods of seeding for hay														*	*	*	*	*	*	*	*				*	*	
Rates of seeding for hay														*	*	*	*	*	*	*	*				*	*	
Rates of seeding nurse crop														*	*	*	*	*	*	*	*				*	*	
Dates of seeding														*	*	*	*	*	*	*	*				*	*	
<i>Timothy</i>																											
Variety tests	*	*	*	*		*	*	*		*		*						*							*	*	
Cutting at different stages of maturity		*																							*	*	
Rates of seeding																									*	*	
<i>Turf Grasses</i>																											
Turf grass experiments	*				*																						
<i>Western Ryegrass.</i>																											
Variety tests for yield and purity ..														*	*	*	*	*	*	*	*				*	*	
Methods of seeding for hay														*	*	*	*	*	*	*	*				*	*	
Rates of seeding for hay														*	*	*	*	*	*	*	*				*	*	
<i>White Dutch Clover.</i>																											
Variety tests for yield and suitability	*		*			*				*		*						*	*	*	*		*		*	*	
<i>Indian Corn</i>																											
Variety tests for ensilage	*	*	*	*	*	*	*	*		*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
Variety tests for the production of grain	*						*						*					*	*	*	*	*	*	*	*	*	
Rows vs. hill planting					*													*	*	*	*	*	*	*	*	*	
Rates of seeding																		*	*	*	*	*	*	*	*	*	
Acclimatization experiments																									*	*	
Breeding	*				*						*		*	*	*										*	*	
<i>Sunflowers</i>																											
Variety tests for yield and purity ..	*	*	*	*		*	*	*		*		*		*	*	*	*	*	*	*	*	*	*	*	*	*	
Breeding of pure strains	*																								*	*	

Botanical surveys, herbarium collections, classification of forage plants and general studies on experimental methods are also dealt with at Ottawa.

In addition, there are under way at the Dominion Range Experimental Station, Manyberries, Alta, the following projects :—

- A study of the vegetative and growth characters of native plants.
- A study of poisonous plants.
- The palatability of native forage plants.
- Determination of nutritive value of common native species.
- The classification of vegetative areas.
- The correlation between soil types and the distribution of vegetative species.
- A study of plant succession.
- Natural revegetation by deferred and rotation grazing.
- Natural revegetation by spring—fall grazing.
- Artificial reseeding of depleted range lands to native and tame forage species.
- Natural revegetation by means of reseeding from protected areas.
- The revegetation of eroded and “ burnt-out ” areas.
- Forage plants for alkaline soils.
- The effect of surface cultivation on the vegetative cover of range lands.
- Improvement of the native vegetative cover by means of the use of fertilizers.
- The relation of frequency and closeness of cutting to the vigor productivity and nutritive value of the vegetation.
- The effect of early spring or late fall grazing on the vegetative cover.
- The influence of grazing upon natural revegetation.
- The influence of climate on plant growth.
- Upland hay production on range lands.
- Regrassing of abandoned fields.
- The productiveness of range lands under protection.
- The forage acre value of range lands.

DOMINION EXPERIMENT FARMS—DIVISION OF CHEMISTRY.

In co-operation with the Division of Field Husbandry and Animal Husbandry, an investigation into the chemistry and economics of the newly proposed close-grazing scheme of pasturage, as carried on under Canadian climatic conditions. Data have been obtained for the past few seasons from the analysis of herbage from experimental plots cut weekly, fortnightly, every three weeks and for hay with aftermath. The nutritive value of the herbage from the several plots is being studied.

DEPARTMENT OF AGRICULTURE—SEED COMMISSIONER, SEED BRANCH, OTTAWA.

Inspection and certification of forage crop seed produced in Canada, together with general matters relating to the production of seed.

Standards for seed crops certified as to purity of variety, trueness to type, origin, or freedom from weed impurities are worked out for the following crops :—

- Chewing's fescue.
- Creeping red fescue (*Festuca rubra* L.).
- Meadow fescue (*F. elatior*).
- Browntop (*Agrostis tenuis* Sibth.).
- Creeping bent (*Agrostis stolonifera* L. var. *compacta* Hartin).
- Velvet bent (*Agrostis canina* L.).
- Alfalfa.
- Red clover (one-cut or two-cut type).
- Sweet clover.
- Timothy.

Crops to be certified as free from specified weeds include alfalfa, alsike, bent grass, brome grass, red clover, sweet clover, western ryegrass.

The same standards for disease as required for registered seed crops will apply to the same kinds and varieties of certified crops.

NOVA SCOTIA COLLEGE OF AGRICULTURE, TRURO.

Since 1920, analyses of feeding materials, especially of grasses, native and cultivated, and roughage grown in this province, have been obtained by the Chemical Department. These analyses were conducted with a view to ascertaining whether or not the application of lime and phosphorus to a lime-deficient soil would be followed by increases in the contents of those materials in the plant. Since 1926, attention has been given to the analyses of native pastures, fertilized and unfertilized. Also to the analyses of various weeds and grasses found on such pastures. Various treatments applied to a sod land and plowed land, have given differences in vegetation, the value of which has been determined by analyses.

ONTARIO AGRICULTURAL COLLEGE, GUELPH, ONTARIO.

Alfalfa. Variety tests for hardiness, adaptability and fodder ; advantages of a nurse crop ; dates, rates and methods of seeding ; manuring ; nationality trials ; dates and frequency of cutting ; sowing at different altitudes at varying rates per acre for seed and fodder.

Millets. Variety tests for seed and fodder ; dates and methods of seeding ; sowing in combination with other crops.

Sunflowers. Variety tests ; dates of seeding ; drill width ; combined with other crops.

Timothy. Variety tests for yield and adaptability, with and without fertilizers.

Red clover. Variety tests.

Sweet clover. Variety tests of biennial and annual varieties for fodder and seed production ; dates and rates of seeding ; cutting biennial varieties at different growth stages for fodder or ensilage ; inoculation ; advantages of nurse crop ; different treatments of biennial sweet clover in the autumn of the first year ; sowing combined with other crops.

White Dutch clover. Variety tests.

Orchard grass (*Dactylis glomerata*). Variety tests.

Soybeans. Variety tests for hay and fodder ; time of cutting ; methods of cultivation ; methods rates and dates of seeding alone or in combination.

Mixtures. Hay and pasture mixtures ; different proportions of (1) peas and oats, and (2) tares and oats ; field corn, sunflowers and soybeans grown separately and in combination ; millets, sorghums, etc., in combination with soybeans and sweet clover ; grasses and clovers alone and in combination ; seeding hay mixtures with different nurse crops.

Breeding of improved strains. Timothy, orchard grass, western ryegrass, alfalfa, sweet clover, red clover, alsike and soybeans.

QUEBEC—MACDONALD COLLEGE.

Agronomy Department. Timothy and red clover are the most important plants used for hay and pasture, white and alsike clover and alfalfa being used only to a limited extent. The untillable pasture areas contain indigenous and naturalized species of bent grasses (*Agrostis* spp.), blue grass (*Poa* spp.) and fescues. Any exotic species to be of value in this area must be sufficiently winter hardy to withstand the severity of the winters and adapted to a soil which tends to be retentive of moisture and acid in reaction.

A considerable amount of timothy and red clover seed is harvested in the province, together with limited amounts of alsike and alfalfa in certain areas. There is no field inspection or certification.

With the aim of improving the hardiness, yield, quality, disease resistance and seed production of hay and pasture crops, considerable breeding work has been carried on at Macdonald College with the following :—Timothy, orchard grass, red clover and alfalfa. Such work with alfalfa and orchard grass has been discontinued for the present in order to devote more attention to timothy and red clover. The breeding method used in the case of alfalfa, timothy and orchard grass has been largely one of self-fertilization, while that employed for red clover has taken the form of a "restricted mass selection." As a result of this breeding work a number of improved strains have evolved which are now entered in comparative yield tests, after which the more promising strains will be multiplied for distribution.

In addition to the ordinary tests to determine yielding ability of the various strains of these crops, special tests of different kinds have been carried out as follows :—hardiness tests with alfalfa ; effect of various cultural treatments with red clover ; influence of date of seeding with two varieties of millet.

In co-operation with other departments and with farmers in the province, studies concerned with the growing of alfalfa and the improvement of pastures are in progress. The effect of lime and fertilizer treatments on the growth of alfalfa are being studied at two places in the province where this crop had previously failed to grow satisfactorily.

A pasture investigation is being carried on along the following lines :—(1) A botanical analysis of the existing flora on untillable pastures. (2) An attempt to improve the yield and quality of this flora by fertilizer and seeding treatments. (3) An economic study of the results of fertilization and rotational grazing of pastures.

One type of pasture experiment, involving fertilization and rotational grazing, is under way at Macdonald College. Two other types are being carried on in the province with the assistance of farmers and the Provincial Department of Agriculture. The first of these involving a comparison of fertilized and unfertilized pasture is in progress on two farms in different sections of the province. The second, representing an attempt to determine the possibilities of improving untillable pasture by fertilizer and seeding treatments, is under way on seven pastures, fairly representative of a dairy farming district near Cowansville, Quebec.

Chemistry Department.

Analysis of timothy and clover hays with parallel examinations of the soils upon which they are growing. Samples of hay, soil and subsoil were taken simultaneously with the co-operation of the Animal Husbandry Department. (Preliminary study in Scientific Agriculture, September, 1926). Work is being continued as a larger scale.

Twenty-six samples of pure timothy and clover hays, cut in the bloom stage in the Beauharnois District, are being subjected to the usual feeding stuff analyses and to determination of calcium and phosphorus. A comprehensive analysis of the soils and subsoils upon which the hays were growing is being made to establish the effect of soil variation on the composition of the hays.

WINNIPEG—UNIVERSITY OF MANITOBA, DEPARTMENT OF AGRONOMY.

A. Plant Introduction Garden for testing all possible plants for forage purposes.

B. Variety tests with different strains and types of :—

- (a) Biennials and perennials, e.g., alfalfa, sweet clover, red clover, alsike, timothy, western ryegrass and crested wheatgrass (*Agropyron* spp.), meadow fescue, awnless brome grass, orchard grass (*Dactylis*) and mixtures of these.

- (b) Annual fodders, e.g., millets, sudan grass, sorghum, sudan grass-sorghum hybrid, teff grass (*Eragrostis tef*), cereal varieties and soybeans.
 - (c) Hoed crops, e.g., soybeans, field corn and sunflowers.
- C. Breeding.
- (a) Biennials and perennials, e.g., alfalfa, sweet clover, red clover, timothy, meadow fescue, crested wheatgrass and western ryegrass (*Agropyron* spp.), awnless brome grass, reed canary grass (*Phalaris*), meadow foxtail, perennial ryegrass.
 - (b) Annual fodders, e.g. Sudan-sorghum hybrid and teff grass (*Eragrostis tef*).
 - (c) Hoed crops, e.g., soybeans and field corn.
- D. Special Investigations.
- (a) Influence of physiological factors on seed setting.
 - (b) Investigations of losses due to leaching of forage crops at various stages of curing.
 - (c) Reaction of various forage crops to repeated exposure to varying degrees of cold.
 - (d) The influence of stage of maturity on the quantity and composition of field corn (maize) varieties.

SASKATOON—UNIVERSITY OF SASKATCHEWAN, FIELD HUSBANDRY DEPARTMENT.

1. Plant Improvement. The systematic improvement of sweet clover (*Melilotus*), alfalfa (*Medicago*), brome grass (*Bromus inermis*), and western rye grass (*Agropyron tenerum*) by breeding.
2. Inbreeding. Studies to determine the effect and possibilities of inbreeding as a method of producing new varieties of open-pollinated crops.
3. Genetics. A study of the inheritance of several characters of economic importance in sweet clover.
4. Fertility studies. Reproduction in sweet clover, alfalfa, brome grass and crested wheat grass. Interspecific crosses in legumes.
5. Root development in sweet clover under different systems of management. A study to determine the best methods of utilizing sweet clover for soil improvement.
6. Grass nursery. A study of native grass species with respect to their value as cultivated crops.

EDMONTON—UNIVERSITY OF ALBERTA, COLLEGE OF AGRICULTURE, DEPARTMENT OF FIELD CROPS.

- Alfalfa. Methods of seeding for hay production.
 Seed setting.
 Inbreeding for strains with homozygous distinctive characters.
 Selection and propagation of high seed-yielding plants.
 Cytology of species of *Medicago*.
 Interspecific hybridisation in *Medicago*.
- Agropyron* spp. Taxonomic and ecological studies of native Alberta species.
 Inbreeding and interspecific hybridisation studies of certain species.
 Cytological studies of species of *Agropyron*.

- Red clover. Production by the mass selection method of strains agronomically suitable for local conditions.
- Timothy. Improvement of the Swallow strain by mass selection.
Inbreeding for strains with homozygous distinctive characters.
- Corn (maize). Yield tests of the most suitable varieties.
Sib-breeding in certain hybrid strains.
- Sweet clover. Nurse crops and their rates of seeding on black soil and gray soil conditions in Alberta.
- Native vegetation. Plant succession on uncultivated slough land.

VANCOUVER B.C.—UNIVERSITY OF BRITISH COLUMBIA, DEPARTMENT OF AGRONOMY.

- Alfalfa. 1. Comparative studies of *sativa*, *media* and *falcata* species.
2. Study of hybrids (*media* × *falcata* cross).
a. Inheritance of form of plant.
b. " " rhizome habit of development.
c. " " flower colour.
d. " " shape of seed pod
e. " " dwarfness
f. Study of genetic factors affecting tripping and seed setting.
3. Production of an improved strain possessing the rhizome habit of development.
- Clovers. (Red clover only).
1. Production of new varieties.
2. Study of physiological and morphological mutations.
3. Clover failure studies.
- Grasses. Timothy, tall oat grass, orchard grass, meadow fescue.
1. Decline of vigour, due to inbreeding.
2. Longevity studies.
3. Economic breeding, including—
a. Selection of superior plants and multiplication of pure lines.
b. Crossing of selected types.

AUSTRALIA.

FEDERAL CAPITAL TERRITORY.

CHIEF, DIVISION OF PLANT INDUSTRY, BOX 109, CANBERRA CITY.

Pastures in the Federal Capital Territory consist almost exclusively of native grasses—*Danthonia*, *Stipa*, *Themeda*, etc., with cluster and burr clover as leguminous constituents. Swards are seeded artificially only to a very limited extent, the species used being Wimmera ryegrass (*Lolium subulatum*) and subterranean clover (*Trifolium subterraneum*). Perennial ryegrass and cocksfoot are used very slightly. Lucerne is grown to some extent on rich soils bordering streams. The low rainfall (not over 24 ins. per annum) occurring largely in winter and spring is the chief factor limiting the use of European species. Wimmera ryegrass fails because it is only an annual, subterranean clover because of its tendency to crowd out grasses and other vegetation.

Danthonia semi-annularis and *D. carphoides* are considered worthy of improvement by selection. A herbarium collection has been made and seed of these and other species gathered. Breeding work, consisting of pure line selection combined with natural selection, is being initiated with these *Danthonias*, with *Glycine tomentosa* and species of *Phalaris*, the main objective being greater productiveness under semi-arid conditions.

The Division of Plant Industry, through its Plant Introduction Section, is undertaking the introduction, from world wide sources, of plants that may be of value in Australia. Preliminary tests are in progress on numerous grass, legume and forage plants. Arrangements have been made with the Queensland Agricultural College for the establishment of a Plant Introduction Station at Gatton, Queensland.

The Federal Capital Territory Commission (now the Department of Home Affairs F.C.T. Branch) has been, and is undertaking, under the guidance and advice of the Plant Industry Division and of the New South Wales Department of Agriculture, experiments in top-dressing of native pastures. Suitable areas have been chosen, and varying combinations and quantities of fertilisers used. Where the natural pasture clovers are apparently absent or inconspicuous, they have been surface-seeded on certain plots. Ball or cluster clover (*Trifolium glomeratum*), hop clover (*T. minus* and *T. procumbens*) subterranean clover, *Medicago lupulina* and lucerne have been used. Although burr clover (*Medicago denticulata*) is common in the Federal Capital Territory, yet it has been omitted from the plots as the burrs get into the fleece of the sheep. The seed of these was covered by use of the "Whakatane harrow," which has given such excellent renovating results on New Zealand pastures.

At Glen Elgin, near Glen Innes, in the northern section of New South Wales, an ecological survey is in progress on a pastoral area that has carried only cattle for many years and that will eventually carry only sheep. A botanical survey and analysis of the area has been completed. Dried specimens of all plant species on the area chosen have been mounted and are being identified, while quadrat percentages of each pasture species have been ascertained. A similar botanical survey will be made during the change-over from cattle to sheep. A record of the species avoided, totally grazed and partially grazed will be kept. Comparisons will ultimately be made to show which species are preferred by cattle and sheep respectively, and which are pastured to the point of depression or even extermination, as alleged, by sheep. Reasons for over-pasturing will be sought. Analysis for cystine will be made by the Animal Nutrition experts in the endeavour to explain the alleged preference for certain species by sheep, which are reported by local graziers to do well for a year or two following the cattle, and then to go off markedly.

WESTERN AUSTRALIA.

PERTH—DEPARTMENT OF AGRICULTURE.

Trifolium subterraneum, *Medicago sativa*, *Paspalum dilatatum* and *Lolium subulatum* are sown extensively. *T. repens*, *T. pratense*, *T. hybridum*, *T. cernuum*, *T. glomeratum*, *Lolium perenne* and *L. multiflorum*, *Paspalum distichum* (roots), *Pennisetum clandestinum* (roots), *P. purpureum* and *Andropogon sorghum* var. *Sudanense* are also used.

The limiting factor in the use of European species is the dry summer in the agricultural belt, from three to six months practically without rain being a normal feature of the climate in all except south coast areas.

Seed production of subterranean clover (200 tons annually) is extensively carried on, that of *T. cernuum* and Sudan grass less so.

MURESK—AGRICULTURAL COLLEGE.

The remarks quoted below refer to the south-west corner of the State. The herbage problems may be placed under two heads.

I. The introduction of new species and varieties, and the more extended use of those species or varieties that are adapted to our soil and climatic conditions. The climate of the area, which has the heaviest rainfall and is the part most suited to the establishment of sown pastures, is one of winter

rains. The conditions are not suited to the growth of summer growing perennials that require summer rains. The climate is Mediterranean, consequently plants from similar areas thrive, whereas most of the species that are satisfactory in Great Britain and New Zealand are of very little economic importance in Western Australia. The species required are therefore :—

(a) Annuals that will germinate with the first winter rains giving green grazing during the winter, while their dry leaves and stalks provide dry feed during the summer. They must be prolific seeders with a high percentage of hard shelled seed to ensure survival the following season.

(b) Perennials with rootstocks that can withstand dry summer conditions, make vigorous growth after rain and during the winter, and will stand grazing.

It would appear therefore that apart from the improvement of naturalised or native species by selection or breeding, the most hopeful procedure is the importation of species from countries with similar climate.

II. The most economical methods of fertilising with special regard to (a) kind of fertiliser, (b) quantity to apply and (c) time of application.

(a) The soils of the area are deficient in phosphoric acid and usually low in nitrogen. It is therefore essential to use a phosphatic fertiliser, while it is an economic practice in many cases to use some nitrogen when first sowing clovers.

(b) The question as to the best quantity to apply requires investigation. There are suggestions that "losses of added phosphates by leaching," as found in North Wales grassland soils, would be experienced.

(c) The time of application is correlated with (b) as with leaching, either several applications in small amounts or one heavier application in the spring, rather than at the commencement of the rains, are indicated.

Many European species have been tried, alone and in grass mixtures, but they seldom form a permanent pasture as the perennials die out and the annuals remain. The chief limiting factors are the long dry summers, the phosphate deficiency with or without accompanying nitrogen deficiency.

Native species such as *Stipa*, *Danthonia*, *Themeda*, *Eriachne* and *Neurachne* are hardy and perennial, give a green bite in the summer and with the first winter rains. *Themeda* would be ideal, providing plenty of green leaf even in the driest part of the year, if it would stand grazing. The species of *Stipa* would be valuable, being hardy and drought resistant, if they could be bred without the long penetrating awns, which not only enter the wool, but grow into the skin and flesh of the sheep.

Cleaned seed of three varieties of subterranean clover which were produced at the Agricultural College, Muresk, is now procurable. Large quantities of the "Midseason" strain are harvested, as this is the variety grown over the greatest area. "First Early" and "Late" are also produced by one grower, several tons of the former being available each year.

SOUTH AUSTRALIA.

WAITE AGRICULTURAL RESEARCH INSTITUTE, GLEN OSMOND.

The main avenue of grassland improvement during the past decade has been through the top-dressing of natural pastures with soluble phosphatic fertilisers, and the extension of areas sown to subterranean clover. The study of herbage plants has not been undertaken to any considerable extent, although trials have been conducted by the Department of Agriculture since 1908, and pre-

liminary investigations of species and strains at the Waite Institute during the last five years have indicated certain problems relating to the establishment of improved types of plants on Southern Australian pastures. Present investigations are confined to the growing of already proved species in replicated grazed plots and as single spaced plants at the Institute, and the testing of promising commercial and pedigree herbage plants under normal grazing conditions at typical grassland centres in the State. At the Waite Institute the question of yield and permanence under both grazing and cutting, and the role of phosphatic and nitrogenous fertilisers are being studied in relation to different species and different strains. Selection within pure lines is being employed as a means of seeking suitable types of (1) *Danthonia* and (2) *Phalaris tuberosa*.

The bulk of the area of seeded pasture in South Australia (90,000 acres) has been sown down to subterranean clover.

The factors limiting the use of European species are (1) unsuitable climatic conditions over the greater portion of the State, (2) lack of suitable strains, (3) lack of knowledge as to the general ecological requirements of the species tried. The chief problem is that of persistence under conditions where the summer months are hot and dry, and where the pastures are grazed by stock for the entire twelve months.

For the more favoured grassland areas of the State, the following species have demonstrated their superiority as herbage plants :—

1. Free-seeding winter annuals—

Lolium subulatum (Wimmera ryegrass).

Trifolium subterraneum (Subterranean clover).

2. Winter growing perennials—

Phalaris tuberosa (Toowoomba canary grass)

Lolium perenne (Perennial ryegrass—Hawkes Bay, N.Z. strain).

Ehrharta calycina (Perennial veldt grass).

Danthonia Duttoniana

Danthonia penicillata

} (Wallaby grasses—selected indigenous strains).

3. Summer growing perennials :—

Medicago sativa (Lucerne—Hunter River strain).

Atriplex semibaccatum (Indigenous creeping saltbush)

Lolium subulatum and *Trifolium subterraneum* have been subjected to selection by the Victorian Department of Agriculture.

Phalaris tuberosa has demonstrated its ability to persist over periods ranging up to twenty years under South Australian conditions, and has further produced high yields of herbage over the autumn, winter and spring period in trials at the Waite Institute. An initial difficulty in the study of this species was the inability to distinguish with certainty the seed of *Phalaris tuberosa* from that of *Phalaris minor*, an annual of considerably less value. It has been shown that the pink radicle tip present in *P. minor* at germination is a reliable means of identification for the annual species, and does not occur in seeds of the true perennial type.

A critical study of *Phalaris tuberosa* in particular relation to seed production, leafiness, vigour and persistency under grazing conditions is in progress. A considerable amount of material has now been collected and wide variations in type are apparent. The grass is normally cross-fertilised (although the annual species, *P. minor* is normally self-pollinated). Over 200 selfings of the perennial species were made in 1929 and 1930, and seed was obtained in all but a few cases. Production varied from only a few seeds in most instances to relatively high quantities of seed in a few plants. With the annual species, seed production is liberal under both selfed and open-pollinated conditions.

Commercial types of *Lolium perenne* have been grown at the Waite Institute since 1925 with little success, but recently permanent types from the Hawke's Bay district in New Zealand have been

found capable of persisting over the arid summer period experienced at Adelaide. It is considered that previous failures of perennial ryegrass to persist under South Australian conditions are due to the use of inferior and naturally short-lived types, and a lack of regard for adequate fertility and management.

A comparative study of the establishment, root and herbage development at varying growth stages, anatomy, drought-resistance and mineral content of a selected but unfixed type of *Phalaris tuberosa* and of Hawke's Bay perennial ryegrass is at present in progress.

Ehrharta calycina is a recent introduction which is capable of persisting under the climatic conditions of Adelaide, and although of slightly lower productivity than *Phalaris tuberosa* and Hawke's Bay ryegrass is of promise, particularly on the lighter soil types of the State. Considerable variation within the species is apparent.

Danthonia species and strains have been collected from different parts of Australia over a number of years, and selections have been made from the material acquired. Species of this genus are highly self-fertile, and in most cases normally self-fertilised. Furthermore, seed of good germinative ability is produced liberally. No critical investigation of the group has been attempted. The immediate aim is to isolate strains of a high degree of persistency and productivity under conditions of fairly rigorous defoliation. The lines have been tested as single plants spaced under field conditions, and plots of the most promising strains have been established. These are definitely lower in productivity than *Phalaris tuberosa*, *Lolium perenne* and *Ehrharta calycina*, but may be more suited to poorer soils and lower rainfall conditions than obtain in Adelaide.

Medicago sativa is the most successful pasture legume for Adelaide conditions, and is capable of providing summer feed by means of a deep root system in contact with subsoil moisture. Breeding and selection work is not at present considered necessary with this species.

Atriplex semibaccatum is the most suitable of the saltbush species for grazing conditions on previously cultivated soils. This species also possesses a deep root system, and moreover has a water requirement approximately only one half that of lucerne. The productivity and seed production in the first year are high. Considerable variation within the species is manifest and selection for longevity may be necessary.

The investigations with different species have been extended recently to seven outside centres in different grassland areas of South Australia. These centres were chosen to represent ranges from moderate to relatively high rainfall, and from low to high soil fertility. An acre of prepared land was employed at each centre, and the first series of plots established in May, 1930.

Different species and strains of ryegrass, *Phalaris tuberosa*, cocksfoot, bent, lucerne, subterranean, white and strawberry clovers, fog and other lesser known species were sown in quadruplicate in 1-tooth acre plots in the wetter areas; *Danthonia* and *Atriplex* types have been sown in the drier localities.

The initial subject for study in each case is the establishment of each species. Some species have already been eliminated at certain centres owing to unsatisfactory establishment. Hawke's Bay ryegrass and *Phalaris tuberosa* have so far been outstanding in their capacity to persist through the dry summer period.

KOONAMORE RESERVE, N.E. SOUTH AUSTRALIA.

Studies on the regeneration of native vegetation in areas where the annual average rainfall is less than 10 inches. Investigations are carried out on this area of 1,000 acres of eaten-out saltbush country, the main object being (a) a study of the regeneration of natural vegetation, (b) study of the effect of grazing of known intensity on the process of regeneration and (c) study of the ecology of the area.

VICTORIA.

DIRECTOR, DEPARTMENT OF AGRICULTURE, MELBOURNE.

Sowing down of pastures is confined largely to areas where the rainfall exceeds 25 inches per annum, and to those districts where irrigation is available. Elsewhere volunteer herbage is relied on, *Danthonia* species being the most important perennials, *Bromus* species and a number of trefoils, e.g., *Medicago denticulata*, the most important annuals.

European species have been tried over the entire State but low rainfall or poor soil fertility are limiting factors. Topdressing with superphosphate is of value, but generally uneconomical. European grasses sown in the moister districts are unstable, other species, particularly *Danthonias*, being intrusive. Improved pasture management should tend to increase stability of European species; this is receiving attention at the present time. The limiting factor to reseeding pastures is the cost, as most of the holdings are extensive. Work is being undertaken to separate out strains within the species, with a view to developing those suitable for sowing down in particular areas.

Native species are rarely used owing to the difficulty in obtaining seed and in forming a satisfactory pasture with them. Native species do not compete with volunteer herbage, which is relied on for feed. *Danthonia* is the principal native species which is considered valuable for reseeding, provided satisfactory germination can be obtained. It is considered that the general vigour of the species could be improved by selection.

Wimmera ryegrass (*Lolium subulatum*), believed to be a hybrid between *L. rigidum* and *L. italicum*, has proved of value in dry areas and on the lighter soils in moister districts. It is very tolerant of drought and excessive moisture, and although an annual, seeds freely. It is being improved by selection and breeding, promising results having already been obtained. Similar work is in progress on subterranean clover. This species can be grown where the rainfall is not less than 17 inches, while Wimmera ryegrass has been successfully established in areas with a rainfall as low as 12 inches.

One pedigree strain of Wimmera ryegrass has been produced and developed by the Department. The cross-pollination characteristic of this plant is a difficulty in extensive production of pedigree seed by farmers themselves. Numerous other strains are still in the preliminary stages.

A number of strains of *Trifolium subterraneum* are being developed and tested under various conditions, some already being available commercially. Self-pollination found in this species renders multiplication an easy matter.

Strains of naturally selected plants have developed in various districts, chief among these being Western District perennial ryegrass and Wimmera ryegrass.

Breeding work is in progress on *Lolium subulatum*, *Dactylis glomerata*, *Trifolium subterraneum* and *T. repens*. Present efforts are largely concentrated on the selection in the field of different species which, after comparative trial, appear to present outstanding advantages. Already it has been shown that strains with widely differing agricultural and botanical characters can be readily obtained. Work is also in progress on hybridisation between pure strains to be followed later by field trials of selected progeny with the object of procuring improved pedigree strains. Individual and mass selections are being made and tested. In hybridisation, the Aberystwyth technique is employed.

Some work is under way on the inheritance of various characters of *Lolium subulatum* and *Trifolium subterraneum*. Owing to the smallness of the flower of the clover, considerable difficulty has been experienced in hybridisations. Three lines of this species have been isolated, having black, amber, and white seed respectively; the inheritance of seed colouration is being studied by hybridisation between the different lines.

Seeds mixtures suitable for pastures in irrigated districts are under investigation.

NEW SOUTH WALES.

DEPARTMENT OF AGRICULTURE, PLANT BREEDING BRANCH, BOX 36a G.P.O.
SYDNEY.

This Branch was established in 1927, taking over from the Agrostologist the selection work already done on lucerne, sorghums and Sudan grass, as well as that in progress with cowpeas, soybeans, velvet beans, field peas, vetches, etc. This improvement work is now carried on as a co-operative effort between the Branch and the Agrostologist.

More than 90 per cent. of the total area of New South Wales is uncultivated, consisting of grass and herbage plants.

Lucerne.

The area under lucerne in New South Wales has been more than doubled when the the acreage for 1917 and 1927 are compared. Tests of local strains and varieties and strains from numerous countries overseas are in progress at the various experiment stations. In most cases, the local strains have been found to be superior. First and second generation seed of desirable lines has been obtained at Bathurst, but, except for a single line, a distinct loss of vigour is apparent. At Yanco, where an attempt is being made to produce a strain for heavy soils under irrigation, F₁ selfed seed has been obtained, but considerable variation still exists. Similar F₁ seed has been obtained at Hawkesbury and Grafton. A definite correlation exists between leafiness and seed setting capacity, the plants with the best vegetative development setting seed comparatively shyly.

Sorghum.

The varieties chiefly grown as fodder are Sumac, white African, Cowper, Saccaline, and an early maturing variety, Oxby. These will be the standard varieties upon which improvement work will be carried out at various experiment stations. Results are given of tests of introduced varieties and the question of resistance to red stain discussed.

Sudan Grass.

As about 80 per cent. of this crop is used for grazing, the evolution of a type for these conditions is considered more important than the selection of hay types. Self-fertilisation has brought more uniformity, but has lead, rather unexpectedly, to a marked loss of vigour.

Summer Legumes.

The observation and testing of introduced varieties of cowpeas, soybeans, velvet beans, etc., have been carried out. Similar work is in progress on winter leguminous crops, such as field peas, vetches, tick beans, lupins, etc., as green manure and fodder crops.

Grasses and Pasture Plants.

Nationality and strain trials are proceeding on red clover, cocksfoot and perennial ryegrass. White clover is of value in coastal districts when mixed with *Paspalum*. Clone studies are in progress on Toowoomba canary grass (*Phalaris bulbosa*). Wimmera ryegrass (*Lolium rigidum* var. *strictum*), *Trifolium subterraneum*, *Paspalum dilatatum*, *Medicago lupulina* and ball clover (*Trifolium glomeratum*) are being studied from various aspects.

QUEENSLAND.

DEPARTMENT OF AGRICULTURE AND STOCK, BRISBANE.

Analyses of Pasture Grasses.

Samples of the natural pastures of various ages from all parts of Queensland are being collected, and fully analysed. Analyses of cultivated grasses, e.g. *Paspalum* and kikuyu (*Pennisetum clandestinum*) are being continued.

Pasture improvement work, including experiments on country recently cleared of prickly pear by *Cactoblastis cactorum*.

NEW ZEALAND.

PLANT RESEARCH STATION, PALMERSTON NORTH.

The following species are under trial :—perennial ryegrass, Italian ryegrass, red and white clover, cocksfoot, Yorkshire fog, browntop, timothy, meadow fescue, *Danthonia* spp., *Lotus* spp., Wimmera ryegrass, crested dogtail and fine leaved fescues. The three most important species to New Zealand from the practical breeding point of view are (1) perennial ryegrass, (2) white clover and (3) red clover. Akaroa cocksfoot is already a high quality pasture type, but later much detailed work will be necessary in working up elite strains from this source.

The following are briefly the aims :—

Perennial Ryegrass.

(a) Elimination from the seed trade of the false perennial types and a building up by scheme of certification of a supply of the true perennial Hawke's Bay and Poverty Bay types for New Zealand requirements at least at a reasonable price per bushel.

(b) Testing of certified lines of these two types to locate any superior pasture types that may exist.

(c) By single plant study, to work up as rapidly as possible by mass strain selection elite types from the Hawke's Bay and Poverty Bay lines. Some 2,000 lines of perennial ryegrass are at present under trial.

White Clover.

(a) Mass trial of all available commercial lines from New Zealand and overseas of varying ages (including all lines certified as old pasture—5 years and over. 900 lines).

(b) Single plant study of all lines that show eye differences at any stages of growth.

(c) Application of certification to those areas now carrying distinct and desirable types of white clover—trials under (a) being conducted primarily to discover where in New Zealand the best types are located.

(d) Working up elite strains by mass selection per medium of single plant work of a definite and proven type which will be grown out under certification scheme.

Red Clover.

Introduction of the Montgomery red clover type. Single plant study and elite strain raising by mass selection of the dense-crowned type.

Reproduction of selected type under certification scheme.

Cocksfoot.

Broadcast trials of numerous New Zealand lines followed by single plant studies of those lines where eye differences appear. Ultimately the working up of elite strains by mass selection of a definite herbage type. Certification of Akaroa cocksfoot.

Crested Dogtail.

Broadcast trials of all available commercial lines and single plant studies as with cocksfoot. Persistency is a major aim.

Yorkshire Fog.

Broadcast and row trials and single plant study of hand collected seed from varying habitats supplemented by lots from dressing machines ex ryegrass, cocksfoot, crested dogtail, etc. The aim is to evolve a persistent leafy herbage type of moderately high palatability for use on certain second class soil types.

Italian Ryegrass.

Broadcast trials and single plant studies to test New Zealand types against American and European. Elimination from the New Zealand seed trade of those false types which appear to be hybrids, Italian $\times$ false perennial.

Browntop.

Broadcast and single plant studies to define type and ensure the correct sward types for lawn and green production purposes.

In addition to the above, *Lotus major*, *Danthonia pilosa*, *Bromus unioloides*, *Phleum pratense* and *Paspalum dilatatum* would all repay work spent on them.

With the technique employed at Palmerston North, the aim is to put each line under a three-fold test.

- (1) In the broadcast under differential mowing treatment.
- (2) As single spaced plants drawn at random from the broadcast plot.
- (3) In a mixed association in the field on several soil types and subjected to normal grazing.

MARTON EXPERIMENTAL FARM.

Studies of the production from pasture at all seasons of the year and under different fertiliser treatments are being carried out by using the lawn-mower as the reducing agent for measurement purposes. By using duplicate areas in some of the experiments sheep are introduced so that the sward can be maintained as under a system of intensive rotational grazing, the whole of the grass being consumed by stock and the resultant animal manure returned to the ground.

Dry matter determinations and in some cases chemical analyses of herbage are made.

The following investigations are being carried out :—

- (1) Determination of the effect of applying superphosphate and basic slag in winter, spring, summer and autumn respectively.
- (2) Determination of the effect of different methods of distributing applications of superphosphate, i.e., heavy applications at infrequent intervals versus light applications at frequent intervals.
- (3) Determination of the relative merits of ammonium phosphate and nitrophoska and mixtures of superphosphate, sulphate of ammonia and complete fertiliser at equivalent amounts of nitrogen, phosphate and potash per acre.
- (4) Study of applications of sulphate of ammonia at two-monthly intervals throughout the year on different plots.
- (5) Study of production from pasture mown at about two to three inch. stage as compared with pasture mown only half as often.
- (6) Determination of the effect of mixing carbonate of lime with sulphate of ammonia at time of application in the proportion of two to one, to find out if there is any loss in the effect of the sulphate of ammonia when compared with the application of sulphate of ammonia on pre-limed ground.

An experiment to determine the carrying capacity of pasture at different seasons of the year under intensive rotational grazing with sheep is also being conducted at Marton. Rate of stocking is varied according to rate of production of herbage so that all herbage is fully utilised.

MASSEY AGRICULTURAL COLLEGE, PALMERSTON NORTH.

Study of *Cynosurus cristatus* (crested dogstail).

CANTERBURY AGRICULTURAL COLLEGE, LINCOLN.

Clone studies of cocksfoot, with classification into different classes, varying from "dense pasture" to "lax hay." The proportion of these classes indicates the average constitution of a cocksfoot stand from an old Canterbury pasture.

In a study of self-fertility, all grades from almost self-sterile to almost fully self-fertile are found.

Selection of desirable types is based primarily on trueness to type, secondarily on yield of off-spring.

Cocksfoot is also being studied with reference to leaf-stem ratio, effect of top-dressing, district plots, effect of sheep grazing, etc.

Self-sterility studies on ryegrass give results similar to those obtained for cocksfoot.

Selection of red clover is based on leaf-producing, disease-resisting, many tillering, late flowering types. Large differences are found in yielding capacity, but in this connection seasonal productivity is important.

A collection of *Danthonia* spp. is being made to study in detail taxonomic and economic considerations. One hundred and ten progeny lines of different types have been planted out as spaced plants.

Cytological studies are being made on the various species, the chromosome number for *D. pilosa*, *D. semi-annularis* and *D. setifolia* having been already definitely ascertained.

CAWTHRON INSTITUTE, NELSON.

Studies on the mineral content of pastures, carried out on behalf of the Empire Marketing Board.

UNION OF SOUTH AFRICA.

DIVISION OF PLANT INDUSTRY, PRETORIA. DRYLANDS STATION, GROENKLOOF AND PRINSHOF.

Studies of South African Pasture Grasses.

Work is concentrated largely on *Digitaria*, woolly finger grass, drought resistant and of better feeding value during the winter months than most of the other indigenous grasses. Practical grazing tests and analysis of strain are also in progress.

Other grasses studied for hay or pasture value include Limpopo grass (*Echinochloa pyramidalis*), Guinea or buffalo grass (*Panicum maximum*), Rhodes grass, kikuyu, antelope grass, dryland grass (*Pennisetum cenchroides*) and others.

At Prinshof, small nursery and demonstration plots of all indigenous grasses of South Africa are in project ; acclimatisation of imported grasses, clovers etc. ; testing under irrigation ; fertiliser trials. Seed production, strains which seed regularly being established by breeding. Carrying capacity as regards sheep grazing tested under dryland and irrigated conditions.

FAURESMITH, ORANGE FREE STATE.

Investigation of Fodder or Karroo Bushes.

Analysis (mineral, etc), of the plants. Definite feeding and carrying capacity tests. These plants, including about twenty genera normally grazed by stock and sheep, belong to the orders Chenopodiaceae, Phytolaccaceae, Nyctaginaceae, Aizoaceae, Euphorbiaceae, Scrophulariaceae and Compositae.

POTCHEFSTROOM. SCHOOL OF AGRICULTURE.

(1) Veld management, the object being to study the effect of different methods of grazing and of burning on more or less typical grass veld of the Western Transvaal.

(2) Veld renovation, to find the best means of renovating worn out or "steekgras" veld.

CEDARA SCHOOL OF AGRICULTURE, NATAL.

(1) Effect on natural pastures of (a) burning, (b) grazing and mowing, (c) top dressing with different fertilisers and (d) frequency of clipping on the yield and composition of fertilised and non-fertilised pastures.

(2) Cultivated pastures, their establishment and economic value in Natal, and the effect of frequency of clipping on *Paspalum* pastures.

GLEN EXPERIMENT STATION, ORANGE FREE STATE.

(1) Testing means of regeneration.

(2) Observing effect of treatment on character and intensity of vegetation.

(3) Demonstrating the effect of seasonal or rotational grazing.

GROOTFONTEIN EXPERIMENT STATION, MIDDELBURG, C.P.

Plots, 22 × 5 yards in size, are laid down in duplicate with the following winter perennial grasses :—

(1) Lucerne, (2) crimson clover, (3) Dutch white clover, (4) *Plantago lanceolata*, (5) sheep's burnet, (6) rescue grass, (7) tall oat grass, (8) Italian ryegrass, (9) New Zealand tall fescue, (10) *Phalaris bulbosa* and (11) cocksfoot.

Manural and grazing experiments.

Comparison of veld and cultivated grasses.

Grazing trials on cultivated grasses, spineless cactus, saltbush and lucerne.

IRISH FREE STATE.

DUBLIN, ALBERT AGRICULTURAL COLLEGE, GLASNEVIN.

(1) Breeding work with herbage plants has been commenced recently, improved strains of cocksfoot, perennial ryegrass, red clover and white clover being studied.

(2) Small scale nationality trials with red clover.

(3) Large scale experiment dealing with the effect of rotational grazing and of the application of manures.

(4) Botanical and chemical analyses of the herbage of different types of pastures.

INDIA.

IMPERIAL INSTITUTE OF AGRICULTURAL RESEARCH, PUSA, BIHAR.

Study of crops for fodder and silage with reference to an upkeep of the fertility of the land and a constant supply of green fodder throughout the year.

Cultivation of berseem under irrigation.

Breeding work on gram, the chick pea (*Cicer arietinum*), the isolation of unit species, the inheritance of seed colour, the study of flower colour and various quantitative characters, and a cytological study with special reference to the chromosome numbers in a mutation observed in a particular type.

Isolation of unit species in Rahar (*Cajanus indicus*), study of flower colour, seed and pod character, height, habit and time of maturity and selection of a resistant type with an attempt to combine this quality with some other desirable morphological characters by hybridisation.

IMPERIAL INSTITUTE OF ANIMAL HUSBANDY AND DAIRYING, BANGALORE.

Feeding experiments with young stock (cattle) to study the nutritive value of Indian fodders from a practical point of view.

Mineral composition of Indian pastures and certain cultivated crops under typical conditions of soil and climate.

Experiments on maturing of Indian fodder crops, including pasture grasses. A study of the changes taking place in composition and digestibility during maturing.

A study of the nutritive value of silage made from various Indian fodders.

CENTRAL PROVINCES. DIRECTOR OF AGRICULTURE AND SECOND ECONOMIC BOTANIST.

Improvement of grasslands in this area is being studied. General survey of the typical grass areas has indicated, not only the suppression of spear grass (*Andropogon contortus*), but the necessity of study of the reasons for the general deterioration in the herbage. These areas have been left to themselves, with the result that injurious weeds and coarser grasses have gradually replaced the finer and superior grasses. Also, as a result of unrestricted and close grazing, valuable fodder grasses have become rare. The more important grasses and legumes found to be of value as regards habit of growth, drought resistance, palatability, nutritive value and yield are as follows :—*Ischaemum sulcatum*, *I. laxum*, *Iseilema laxum*, *Andropogon annulatus*, *A. caricosus*, *A. pertusus*, *A. purpureosericeus*, *A. monticola*, *A. pumilus*, *Apluda varia* and the legumes *Alysicarpus rugosus* and *Indigofera linifolia*.

Preliminary plot trials have indicated the advisability of growing a judicious mixture of grasses selected with due regard to the differences in their habits of growth, light and soil requirements.

Quadrat observations have shown that *Andropogon contortus*, *A. triticeus* and *A. schoenanthus* continue to be dominant in the check plots, whereas in the reseeded areas the herbage consists of such nutritious and palatable grasses as *Ischaemum sulcatum*, *I. laxum*, *Andropogon annulatus* and *A. pertusus*.

Further work is in progress along the lines indicated.

PUNJAB—DIRECTOR OF AGRICULTURE.

The amount of grasslands in the plains is very small, the pastures which exist being situated in the forest areas in hilly tracts. There are practically no sown out swards, the grasslands being natural. The main problem is the evolution of a herbage plant which can bear extreme drought, and can be utilized in reclaiming the bare and depleted grazing areas. The study of the wild indigenous grasses which might be sown broadcast is thus important. Owing to the small size of the holdings, crops used as pasture in other parts of the world are here siloed. The high summer temperature coupled with a long dry season are the chief factors limiting the use of European species.

Some selection work is in progress on the following species :—*Cyamopsis psoralioides*, *Pennisetum cenchroides*, *Cenchrus biflorus*, *Trigonella foenum-graecum* and *Melilotus parviflora*.

Trifolium alexandrinum (berseem) is studied for yield, and production and quality of seed.

Lucerne variety tests are carried out.

BOMBAY—DIRECTOR OF AGRICULTURE.

The study of grass areas, with the object of forming a dairy district. Experiments with miscellaneous forage crops, e.g. *Cicer* and *Pisum*, berseem under irrigation. Some difficulty is found in seed production in berseem, the yield being apparently better in Upper than in Lower Sind. The use of elephant grass (*Pennisetum purpureum*) as a fodder. Yield of lucerne. Breeding work on *Pennisetum typhoideum*, with testing of promising varieties by the chessboard method. Owing to absence of distinctive appearance in valuable strains, colour is now being bred into the stems.

The improvement of poor grassland, manufacture of silage, rotational grazing, dry grass production, etc.

SIND—AGRICULTURAL RESEARCH STATION, SAKRAND.

Matters connected with grassland and herbage species have not received much attention up to the present, but investigations on the following lines would be of value :—

- (a) The most suitable fodder crops for spring and autumn.
- (b) Seed production in *Trifolium alexandrinum*.
- (c) Better utilization of hay and straw (millet and rice) and storage for famine years.
- (d) Manufacture of silage.

Beyond natural herbage, no seeds are sown in pasturage grounds. Fodder (summer) crops cultivated include sorghum (for green fodder and dry straw), *Cyamopsis psoraloides*, *Vigna catjang* and other legumes. As winter crops, berseem and some barley are grown for fodder. Perennial forage plants include lucerne, elephant grass (*Typha elephantina*?) and guinea grass (*Panicum maximum*).

Pedigree strains of saccharine sorghum specially suited for green forage are being raised at Sakrand. Collection of these plants and subsequent selection and breeding are in progress.

BIHAR AND ORISSA—DIRECTOR OF AGRICULTURE.

Possibility of grassland improvement is strictly controlled by prevailing economic conditions. Generally grazing grounds are common to villages. Any system of rest or rotation is unknown and the so-called grasslands generally produce a visible supply of grass only during the monsoon.

Work on fodder crops, especially leguminous catch-crops under irrigation, promises better results as their cultivation is carried out on privately owned land. Grazing fodder crops on arable ground seems the most practical and feasible method of conserving the natural manure which is at present largely wasted on the common grazing grounds. There is much scope for the trial of exotic fodder crops.

MADRAS—DIRECTOR OF AGRICULTURE.

Except on the Live Stock Research Stations at Hosur, Salem District, Chintaladevi, Nellore District and the Agricultural Research Stations at Nanjanad, Nilgiris District and Hagari, Bellary District, no work on herbage species is likely to be done. *Dactylis glomerata*, *Bromus unioloides*, *Paspalum dilatatum* and a species of white clover have established themselves in the Botanic Garden at Ootacamund. There is a large area of grazing land in this district which could be much improved.

The long dry hot weather period is the chief factor limiting the use of European species.

Hosur Live Stock Station.

Rainfall, especially its distribution, is an important factor in the management of the grassland. The bulk of the area is covered with spear grass (*Andropogon contortus*), but some special pastures are under Rhodes grass (*Choris gayana*) and *Pennisetum cenchroides*. There are also other *Andropogon* species, and two varieties of *Digitaria sanguinalis*. Legumes are not present, but attempts are being made to introduce *Phaseolus semi-erectus*.

UNITED PROVINCES—DIRECTOR OF AGRICULTURE.

The sowing of grass seeds, e.g. *Cynodon dactylon*, for swards is limited to gardens and sport grounds.

Various European species have failed, but certain introductions from Australia, e.g. *Paspalum dilatatum* and *Chloris gayana* appear to be promising under irrigation.

Indigenous species present include *Pennisetum cenchroides*, *Andropogon Ischaemum* and *Andropogon contortus*; the following are successful under irrigation and are propagated vegetatively, *Pennisetum purpureum*, *Panicum maximum*. Some lucerne is harvested for seed.

BENGAL—DIRECTOR OF AGRICULTURE.

There is little grassland. Attempts are being made to introduce heavy-yielding strains of juar (*Andropogon sorghum*) and maize as silage for cattle during the dry months. Saccharine sorghums are also being tried at the Government Farms, with *Pennisetum typhoideum* and some short-lived Saccharine sorghum varieties as catch crops.

Perennial fodder such as *Pennisetum purpureum* and *Panicum maximum* with *Andropogon* species (*Andropogon purpureo-sericeus*, *A. monticola*, *A. pertusus* and *A. annulatus* are being studied for yield alone and in suitable mixtures.

Legumes under trial include imported varieties of *Vigna catjang*, *Mucuna*, *Phaseolus* and several wild legumes.

The effect of heavy manuring on the yield and composition of ordinary pasture grasses is also being investigated.

ASSAM—DIRECTOR OF AGRICULTURE.

Natural pasture grasses in Assam are mostly coarse, reedy and fibrous except when young. Made pastures are unknown, all grazing being common. *Paspalum dilatatum*, introduced some twenty years ago, has established itself in the hills. Guinea grass and elephant grass do well in all parts of the Province. Other gramineous fodders which have been tried with some success include maize, millets, *P. distichum* and *Cynodon dactylon*. Owing to the heavy rainfall and extended wet season (March—October) permanent grasses give many cuttings without irrigation and produce yields in excess of those of annual fodder crops.

Many legumes have been tried on the experimental stations from time to time, but most of them require lime for proper growth. *Phaseolus Mungo* is successful in the new alluvial tracts; cowpeas do well, generally being used as green manure for tea; lucerne and berseem make fair growth if sown in October, but die out in the following monsoon season (May).

A great need in Assam, as in the rest of India, is for a grazing legume which will establish itself amongst the natural grasses.

Test plots of mixtures of the better Indian grasses were started in 1930. Some imported varieties, amongst which are *Pennisetum purpureum* and blue grass (*Paspalum dilatatum*) are under observation. Also a study of the natural fodder grasses in the plains districts of Assam is in progress.

DIRECTOR OF FARMS. ARMY HEADQUARTERS.

Grasses used include *Cynodon dactylon*, *Pennisetum cenchroides*, *Andropogon annulatus*, *A. Ischaemum* and *A. contortus*. Several European species tested have failed to establish themselves in an unirrigated sward, the limiting factors being a long growing season, low humidity, long dry hot weather and high salt content of soil in certain areas.

Andropogon annulatus could probably be much improved by selection and breeding. Variety tests of lucerne indicate difficulty in seed setting.

BURMA. DIRECTOR OF AGRICULTURE AND ECONOMIC BOTANIST.

There is no proper grassland in the plains, the only species grown for fodder by the natives being sorghum ; lucerne and *Pennisetum typhoideum* have given some results under irrigation.

Sorghum is being studied to obtain a type resistant to *Sphacelia* disease, with a soft juicy sweet stem and a grain suitable for human consumption. Selection and trials of exotics have been in progress for a few years.

The true grasslands, long rolling downs, of the Shan States, are outside the sphere of the correspondent.

SOUTHERN RHODESIA.

DIVISION OF PLANT INDUSTRY, DEPARTMENT OF AGRICULTURE, SALISBURY.

Pasture research as carried out in Southern Rhodesia may be divided into two sections :—

- (a) The improvement of natural grazing veld.
- (b) Testing out of indigenous grasses and legumes, etc., with a view to the laying down of permanent pastures of such species as prove suitable for the purpose.

(a) *Improvement of Natural Grazing Veld.*

Two areas have been made available for these investigations. One in Matabeleland of 240 acres, of which 180 acres consist of black clay loam and 60 acres of poor bodied granite sand, and one in Mashonaland of about 500 acres of typical granitic sand, originally heavily wooded and carrying very little grass, the lower portion being vleiland covered almost entirely with a variety of sedges.

The plan of research in progress at present is designed to determine the following points—

- (1) The influence of regular cutting on the mineral and protein composition of the pastures.
 - (2) Normal seasonal variation in the composition of the grass.
 - (3) The influence of treatment with various fertilisers on the yield of hay, and the botanical and chemical composition of the herbage.
 - (4) The influence of treatment with various fertilisers on the carrying capacity of the land and on the rate of growth and productivity of young growing animals.
 - (5) (as regards the wooded areas). The influence of stumping and clearing the land on the botanical composition and carrying capacity of the veld herbage.
 - (6) The influence of soil and climatic conditions on the chemical composition of a grass.
- (b) *Testing out of Indigenous Grasses and Legumes, etc.*
- For the purpose of laying down pure and mixed permanent pastures of such as prove suitable.

Experiments are being carried out to test :—

- (1) The reaction of the most promising indigenous grasses and legumes, etc., to cultivation.
- (2) Their palatability and nutritive value.
- (3) Their suitability to various soil and climatic conditions.
- (4) The reaction of individual species to grazing, cutting, fertilising, etc.
- (5) The carrying capacity of individual species under different treatments.

The more promising of the grasses at present under investigation are :—Pentz's woolly finger grass (*Digitaria Pentzia*), Milangi finger grass (*Digitaria Milangiana*), turf grass (*Ischaemum laucostachyum*), Rhodesian blue grass (*Andropogon gayanus*), Rhodes grass (*Chloris gayana*), Nyassa red top (*Rhynchelytrum nyassanum*), reed timothy (*Setaria phragmitoides*), golden timothy (*Setaria sphacelata*), large seeded false *Paspalum* (*Brachiaria brizantha*), creeping false *Paspalum* (*Brachiaria dictyoneura*), swamp couch (*Hemarthria fasciculata*), kikuyu (*Pennisetum clandestinum*).

The greater number of the indigenous perennial grasses are found to be very poor seeders. Experiments are in project for the production of seed bearing strains, but at present propagation is almost entirely by root division.

BARBADOS.

DIRECTOR—DEPARTMENT OF AGRICULTURE.

The improvement of Barbados pastures by the introduction of exotic varieties of grass is in project.

BERMUDA.

DIRECTOR—DEPARTMENT OF AGRICULTURE.

No work in progress. Perhaps some species of clovers or other legumes suitable for local conditions, that is, thin calcareous soil, high temperatures and periods of drought might be worthy of trial. The principal species in the herbage are crab grass (*Stenotaphrum secundatum*) and Bermuda grass (*Cynodon dactylon*).

BRITISH GUIANA.

DIRECTOR—DEPARTMENT OF AGRICULTURE.

Cultivation of herbage plants is done on a very small scale. Para grass (*Panicum barbinode*) and Bahama grass (*Capriola* (*Cynodon*?) *dactylon*) are introduced plants, carpet grass (*Axonopus compressus*) indigenous. The Demerara primrose (*Asystasia gangetica*) has proved an excellent feeding crop. Botanical and chemical analysis of pastures and analysis of soil are in progress.

CEYLON.

ECONOMIC BOTANIST. DEPARTMENT OF AGRICULTURE, PERADENIYA.

There is no sown or cultivated pasture. Grasses generally cultivated for cutting as green fodder, such as *Panicum maximum*, *Paspalum dilatatum* and others may occasionally be grazed. The chief limiting factors to the employment of European or any other species in grassland improvement are considered to be (1) the backward state of agriculture in general and (2) the absence of facilities or lack of inclination to fence in pasture land. Fodder grasses are under trial at Peradeniya.

CYPRUS.

DIRECTOR OF AGRICULTURE.

It is considered that the area and conditions of grassland on the Island warrant early investigation. The lines on which investigation are proposed are intensive pasturing with a view to the introduction of pasture reserves under the following groups :—

- (1) The improvement and control of communal grazings.
- (2) The improvement and control of grazings on waste land apart from forest reserves.
- (3) The improvement and encouragement of private grazing areas under permanent and temporary pastures.

The native species growing on permanent pastures are the natural grasses of the Island. Lucerne and *Trifolium alexandrinum* are cultivated under irrigation to a small extent for feeding to animals.

Strong drought-resistant deep-rooted European species might usefully be tried. A large number of species have been and are now under trial, notably a collection from New Zealand.

Certain drought-resistant varieties, such as *Pennisetum* and *Atriplex*, appear to do well.

STRAITS SETTLEMENTS AND FEDERATED MALAY STATES.

ECONOMIC BOTANIST—DEPARTMENT OF AGRICULTURE, KUALA LUMPUR.

No detailed study of herbage species has been made, although some attention has been given to the introduction of exotic grasses which might prove of value locally.

The question of grassland improvement warrants investigation, more particularly in the temperate mountain districts now being opened up for settlement. Studies in the hot lowlands could be made with several indigenous pasture grasses such as *Paspalum*, *Panicum*, *Digitaria*, *Axonopus*, *Zoysia*, *Cynodon* and *Chrysopogon*, which form stable or unstable communities according to environment. Unless the pastures are well grazed or regularly cut and weeded, they are unstable, becoming quickly smothered by lalang grass (*Imperata arundinacea*) or the sensitive plant (*Mimosa pudica*).

Pastures are established by planting vegetative portions of the species desired. This is rarely undertaken on a large scale, the grass most commonly used being an introduced narrow-leaved variety of *Axonopus compressus* Beauv. Temperate pasture grasses might thrive in the highlands (3,000—5,000 ft.) but doubts are entertained as to their seed setting capacity.

The most satisfactory herbage plant in local experience is *Panicum maximum* (guinea grass). Rootstocks of this grass are planted at two feet intervals in rows four feet apart and the grass is cut periodically at three-weekly intervals when it is about one foot high. Crops of 40-50 tons of fresh fodder per acre per annum are easily obtained with good cultivation and an occasional manuring.

FIJI.

DIRECTOR—DEPARTMENT OF AGRICULTURE.

The dairying industry may now be regarded as firmly established, but there remains much to be done, particularly in connection with pasture investigation. Work to date has been spasmodic, several exotic grasses have become established, but suitable mixtures of fodder grasses for the particular conditions in Fiji have not yet been evolved.

An experiment is being laid down with various mixtures under different systems of treatment on a 12 acre block on an Experiment Station in the wet area of the Colony, where conditions are similar to those obtaining in the dairy farming districts.

Forage plants used include *Panicum barbinode* (para grass), *Paspalum dilatatum*, *P. conjugatum*, *Panicum distichum*, *P. sanguinale*, *P. colonum*, *P. consanguinea*, *P. maximum*, *Eleusine indica*, *Tricholaena rosea*, *Setaria glauca* and *Cynodon dactylon*.

Mimosa pudica is regarded as a valuable nitrogenous fodder plant, although the sharp thorns are a disadvantage. There are seventy species of *Desmodium*, but they are not considered of much value as fodder plants.

Trials of exotic species have given little success. The chief limiting factor would appear to be the moist tropical climate; mineral deficiency and the possible absence of the correct root-nodule bacteria for legumes may also be of some importance.

Further trials with lucerne should be of value, partial success having already been obtained.

The reasons for failure with the species used in sowing down pasture are:—lack of palatability in some, but more commonly lack of nutritive qualities due to (a) rapid growth, soon even to rank-

ness (resulting in excessive indigestible fibre and even putrefaction, in the lower layers of some, grasses with corresponding deficiency in digestible carbohydrate, fat and protein), (b) possible mineral deficiency.

Possibly the only native grass of importance is the giant reed-like *Mesanthus japonicus*, which covers the landscape where forest is absent. It is rather coarse and indigestible, although after the grass fibres, the young growth is excellent grazing. Generally, it is not of such good quality as grasses similar in type, e.g., elephant grass and Sudan grass, but with its ready seedsetting, something might be done in the matter of selection and breeding.

The control of noxious weeds in pastures is an important problem in Fiji. Spraying sodium chlorate is of value with *Clidemia hirta*, but with *Lantana* and blue rat tail such measures meet with little success. Biological control is also being studied.

GAMBIA.

DIRECTOR—DEPARTMENT OF AGRICULTURE.

No Cultivated Herbage Plants. The dried vines of the ground nut plant are fed to stock. Otherwise the animals range throughout the bush and feed on any available succulent fodder, especially during the nine months dry season.

GOLD COAST.

ECONOMIC BOTANIST—DEPARTMENT OF AGRICULTURE. TAMALE.

Grassland work has only recently been started and is at present concentrated in the Northern Territories, where investigations are being carried out by the Department of Agriculture in collaboration with the Department of Animal Health.

The work is planned on the following lines :—

(a) A preliminary botanical survey of the grasses of the Northern Territories. This study is nearing completion.

(b) Analysis of some of the more common pasture grasses. This is done by courtesy of the Royal (Dick) Veterinary College, Edinburgh, and the Royal Botanic Gardens, Kew. Certain grasses give a very good protein or mineral content, notably *Dactyloctenium aegypticum*, *Manisuris granularis* and *Paspalum scrobiculatum* var. *commersonii*.

(c) Small trial plots of pure stands of various promising grasses are now being tested on different soil types.

(d) Several trial mixtures will be made up and tested on different soil types.

(e) Investigations are to be made as to the best methods of economically establishing pastures under the primitive methods of farming practised.

(f) In conjunction with the above work, feeding tests will be carried out.

(g) Tests of a number of exotic and indigenous fodder crops have been made, but the only ones that appear promising are Cumow tall corn, a species of South African guinea corn, and *Digitaria exilis*, an indigenous West African grass cultivated as a cereal in several parts of West Africa.

KENYA.

OFFICER IN CHARGE OF GRASSLAND IMPROVEMENT—SCOTT AGRICULTURAL LABORATORIES, NAIROBI.

About 140,000 square miles out of a total land area of 219,731 square miles represent the grazing lands of the country, consisting of large tracts of natural pasture which appear to be utilized in a wasteful and haphazard manner, and which call for improvement either by a change in system of management or by the establishment of reseeded pastures. A grassland survey at present being undertaken should assist in indicating the type of improvement which should be adopted.

No herbage species are used for sowing out swards. *Pennisetum clandestinum* is occasionally established on small areas by means of vegetative propagation. Isolated experiments have been made with European species by settlers at higher altitudes. The chief limiting factors appear to be (a) altitude, i.e., they will be suitable only at higher elevations and (b) the present method of farming. Introduction of fencing and more rational grazing systems may help to make reseeding an economic proposition.

Among grasses which are probably valuable, but about which little is yet known are *Pennisetum* spp., *Cynodon* spp., *Chloris gayana*, *Panicum* spp., *Themeda triandra*, *Setaria* spp., *Paspalum scrobiculatum* var. *commersonii*, *Brachiaria* spp., *Echinochloa* spp., *Hyparrhenia rufa*, *Eleusine indica* and types of *Eragrostis*, *Rottboellia*, *Leptochloa*, *Amphilophis*, *Cymbopogon* and *Sorghum*.

Other herbage plants which may prove useful are several indigenous clovers, e.g. *Trifolium johnstonii* and a number of *Commelina* species.

MALTA.

OFFICE OF AGRICULTURE.

There is no grass land and no pasture proper. Cereals are grown for green forage in crop rotation. Leguminous crops grown for forage (green or dry) and coming into the rotation include sulla (*Hedysarum coronarium*), caterpillar plants (*Scorpiurus subvillosa*), vetchling (*Lathyrus ochrus*) and bitter vetch (*Vicia Ervilia*). The many native species of *Medicago*, *Melilotus*, *Trifolium*, *Lathyrus*, *Vicia* and *Hippocrepis* are never sown or grown purposely.

MAURITIUS.

DIRECTOR—DEPARTMENT OF AGRICULTURE, REDUIT.

The stock raising industry is of very minor importance, being confined to lands unsuited to sugar cane cultivation. The spontaneous herbage is largely *Stenotaphrum complanatum* and *Andropogon contortus*, affording poor fodder. Several attempts to introduce exotics, e.g., kikuyu grass, have been made, but no large scale improvement can be commenced at the present time.

Investigations are in progress on the mineral contents of the pasture grasses of the Colony.

NIGERIA.

DIRECTOR—AGRICULTURAL DEPARTMENT, IBADAN.

As the total head of stock in the country does not approach the carrying capacity of the very extensive grazing areas, there has been little need to study the question of grassland improvement. Experiments have, however, been started on the experimental farms, where, with the attempt to introduce a system of mixed farming and the improvement of the local breeds of cattle, grassland has assumed greater importance.

Information is to be obtained from these experiments on the following questions :—

- (a) The use of native species of grass in the formation of improved pastures.
- (b) The effect of continually mowing for hay and of close grazing on grassland.
- (c) To compare with these the effect of the native method of burning the grass in the dry season.

The real problem at the moment is to find (a) a forage crop which will provide fresh fodder throughout the dry season and (b) a crop which can be planted at the commencement of the rains in April, will yield a heavy crop of fodder for hay in June, then to be turned in to allow of cotton being planted early in July. Many different types of leguminous crops are being tested with this object in view.

NYASALAND.

DIRECTOR—AGRICULTURAL DEPARTMENT, ZOMBA.

Little attention is given to fodders, other than the growth of some maize for silage and the occasional propagation of napier fodder (*Pennisetum purpureum*) by cuttings for extra grazing.

Plans have been made for investigation of local fodder grasses on a central experimental station it is hoped to institute shortly, and the question of the bush burning which takes place over the whole country in the dry season has been taken up with special reference to the effect of the burning on vegetation, soil degeneration and soil erosion. A committee has been appointed to consider the question.

PALESTINE.

Field experiments are in progress to ascertain :—

- (a) the influence of fertilizers on the yield of hay, and
- (b) the effect of grazing by different classes of stock fed separately and in association.

SEYCHELLES.

DIRECTOR—DEPARTMENT OF AGRICULTURE.

The dairy and cattle industries are not extensive. In the tropical herbage, buffalo grass (*Stenotaphrum complanatum*), *Panicum maximum* and *Cynodon dactylon* are the dominant species, tolerating the shade of the coco-nut palm under which the herds of cattle are kept. *Pennisetum setosum*, *Panicum ovalifolium* and *Digitaria* species are indigenous in the hills. Various introduced plants have done well. Of leguminous plants, the indigenous *Desmodium heterophyllum* is palatable to cattle, while occasionally velvet beans (*Stizolobium atropurpureum*) and indigenous cowpeas (*Vigna* species) are used as fodder. *Asystasia coromandeliana* has now become a most valuable forage plant for stock.

TRINIDAD.

Chemical analysis of locally grown fodders and fodder grasses to ascertain their nutritive value. A study of the effect of certain top-dressings, such as lime, on the botanical and chemical composition and feeding quality of pastures.

UGANDA.

DIRECTOR—DEPARTMENT OF AGRICULTURE.

Most of the stock is owned by pastoral tribes with large tracts of common grazing land at their disposal, with ability to move their flocks and herds from one place to another according to the grazing available. Pasture investigations have not therefore been required to any extent.

With the restricted movement of stock on account of diseases and with the introduction of high-grade stock, and the increase in numbers of stock owned by non-natives, more attention is being paid to this subject.

A few simple experiments with regard to nutritive value and yields of native grasses have been carried out some years ago, while a large collection of indigenous grasses was made and listed. A further list is now in course of compilation. Certain indigenous plants other than grasses are also known to be of some value, notably certain legumes, species of *Alysicarpus*, *Dolichos* and *Trifolium*.

Conditions are very different from those of Europe owing to growth being more or less continuous, except for dry periods, and the prevalence of grass fires which have lead to the survival of savannah grasses and other plants that can adapt themselves to these conditions.

The possibility of planting large areas with special pasture plants would seem out of the question for many years, but the effects of checking grass fires, enclosing portions of grazing lands, periodic grazing and resting, the causes relating to the increase of, and best means of reducing, comparatively useless and (or) injurious plants, are but a few lines of investigation along which it should be possible to obtain results which would lead to considerable improvement in the grazing lands of Uganda, without any serious disturbance of the traditions and customs of the indigenous pastoral tribes, the majority of which are slow to adopt European methods of feeding and rearing of stock.

SUDAN.

AGRICULTURE AND FOREST DEPARTMENT—PLANT BREEDING SECTION.

The Northern Sudan is arid, or semi-arid, crops being grown almost entirely under irrigation. Limited quantities of lucerne are grown ; a short period leguminous crop is cultivated in the main Gezira cotton area, being included as a nitrogenous crop and giving one or two cuts of fodder for ploughing bulls. *Dolichos lablab* is most suitable for this purpose.

In the Southern Sudan a short close growing grass, which would practically establish itself, and when established, keep down the normal tall growing herbage might be usefully employed provided it would stand an almost totally dry season of two to three months.

Observations on irrigation studies are in progress on *Dolichos* and *Cajanus*, while trials are also being carried out with forage crops such as the Bengal bean and certain grasses.

TANGANYIKA TERRITORY.

The fodder question is being studied more from the animal nutrition aspect, the aim being to find what the cattle roaming through the Savannah forest really do eat. The shortage of grassland may not be so unfortunate as is generally accepted, many cattle probably of necessity eating less grass than they do herbs and tree leaves. The problem is how to supply food of sufficient energy value ; until this is solved the question of deficiency of vitamins or any other mineral substance other than common salt may be left on one side.

D. INDEX OF GENERA.

The following list of genera includes all those mentioned in the various reports comprising this Bulletin. The generic and specific names supplied by our correspondents have almost invariably been used, but in a few cases a newer systematic position is indicated by the names in brackets. It should not therefore be assumed that the list is infallible from the point of view of the systematist.

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